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UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF AGRICULTURAL ECONOMICS

Economic Aspects of Local Potato Warehouse Organization

John D. Black, Budd A. Holt, and George M. Peterson
Division of Agricultural Economics

UNIVERSITY FARM, ST. PAUL

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ECONOMIC ASPECTS OF LOCAL POTATO WAREHOUSE ORGANIZATION

By John D. Black, Budd A. Holt, and George M. Peterson

This bulletin deals especially with the problems of organization of local potato warehouse units as distinguished from the problems of operating and managing such units after they are set up. Of the three phases of organization, namely, economic organization, financial organization, and business organization, this bulletin considers the first. Problems of management and financial and business organization the readers will find discussed, especially from a co-operative point of view, in Minnesota Bulletin No. 195, "Local Co-operative Potato Marketing in Minnesota." The conclusions and data should be of use in planning new warehouses and reorganizing present ones upon more efficient lines.

SOURCES OF DATA

The data used in this bulletin were obtained entirely from a survey made in co-operation with the United States Department of Agriculture in the winter of 1922-23 for the year 1921. The data obtained, however, were far from being adequate for a full and accurate analysis of the problem.

The survey included 71 warehouses, classified as follows: line, 33; co-operative, 26; independent, 12.[1] These three types will be referred to hereafter in this bulletin as "line houses," "co-operatives" and "independents." The 33 line houses were owned and operated by three different wholesalers. Three warehouses operated by one company were included with the independents because their organization closely resembled that of the independents. Figure 1 shows that the survey represents a well-distributed sample of the commercial potato acreage of the state.

METHODS OF ANALYSIS

The data for each of the seventy-one warehouses were put through a separate set of cost accounts, this resulting in a set of Labor, Building and Site, Equipment, Office and Management, and Other Direct Costs per warehouse and per hundredweight of potatoes handled. These warehouse and hundredweight costs were then analyzed by statistical methods to show ranges and variations and reasons for these variations. The costs themselves are of very little significance—it is the causes of the variations and amount of effect of the different causes that are

[1] Five other warehouses were visited, but only part of the data needed were obtained from them.

really significant. Unfortunately, as already explained, the data obtained were not sufficiently complete to make possible a very full analysis. The causes could be discovered in most cases, but their relative effects could not be accurately measured.

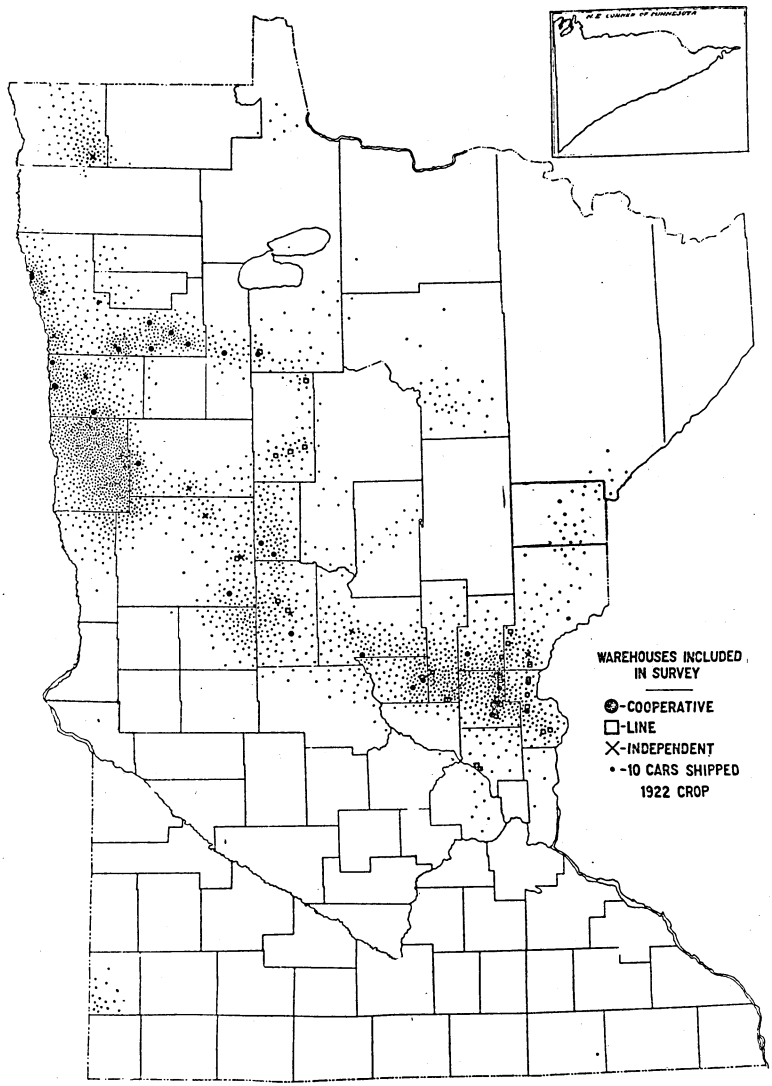

Fig. 1. Distribution of Minnesota Potato Acreage, 1922, and of Warehouses Included in the Survey

ORGANIZATION OF THE POTATO MARKET

The problems of organization of local potato warehouses are considerably affected by the organization of the potato-marketing process as a whole.

Minnesota potato production really is of two sorts, an early crop which begins coming into the market about the middle of July, and the regular main crop marketed from October to June. The early crop is produced just north and east of the Twin Cities, and is marketed in a manner somewhat different from the late crop. Part of the early crop is harvested before thoroly mature, and is trucked to the Twin Cities for immediate consumption; but a considerable quantity is loaded directly into cars and shipped to markets outside the state. The early crop is usually sorted by hand—machinery bruises immature potatoes considerably. The primary considerations for the early stock are to keep it moving, to prevent heating, and to reach market as early as possible.

The greater proportion of Minnesota potatoes, however, is of late varieties produced for winter table stock, or as in the case of the Red River Valley Early Ohio, early varieties which are harvested late to be used for southern seed stock. Marketing methods for late table stock and early seed stock are very similar. Potatoes for late winter and spring consumption or for seed must be carefully stored. If stored long they must be carefully sorted to remove the diseased or frosted tubers. No data are available as to the proportion of potatoes stored on farms, in local warehouses, and in the central market, but the local warehouses are the major factor.

Storing in the local warehouses has several advantages over storing on farms or in the terminal markets: (1) Proper storage requires protection from frost and heat, and also adequate ventilation; and few farmers have adequate facilities for these. (2) Potatoes stored on farms cannot be delivered in cold weather. Farm storage also assumes that farmers are willing to take the risk of price fluctuations and are financially able to do so.

While a certain amount of storing is necessary in terminal markets, the local warehouse has more advantages. (1) Some kind of warehouse must be provided in the local market to receive, grade, and store temporarily preparatory to shipment; and the additional cost of adding a basement to this warehouse is relatively small. (2) The decayed potatoes that develop in storage do not have to be transported when potatoes are stored locally. (3) Potatoes can be shipped directly from local to consuming centers as they are needed—saving freight and reconsignment expense. (4) Potatoes are often stored in bulk in local warehouses, and sorted and sacked only when they are to be

shipped to consuming centers; whereas if they are stored in the central market, they are usually sacked in the local market, then dumped and resacked in the central market.

In the late-potato areas there may be from 1 to 15 warehouses at a shipping point. In addition to the line houses, co-operatives, and independents, large producers may have private houses.

In 1920 there were 136 co-operative warehouses in Minnesota, each owned by a local warehouse association. These associations sell their products in various ways. Some make connections with farmers' clubs, or consumers or stores in the South, or with other large direct buyers, and sell their crop direct. Others sell what they can on track to traveling buyers, and dispose of the balance to large dealers or through the regular brokerage channels. Some operate on joint account with a central wholesaler, or buy on commission for a dealer. In 1920 an attempt was made to federate these associations into one large co-operative sales agency—the Minnesota Potato Exchange. This organization failed after three years, but has been succeeded by a new organization, the Minnesota Potato Growers Exchange, now in its first year of operation. The new organization is of the non-stock centralized type. It has contracts with about 13,000 growers covering approximately 160,000 acres of potatoes and is operated on a seasonal pooling plan, and at present is selling through a national brokerage concern. Its volume of business for the first year will reach about 10,000 cars.

The independent buyers are usually of the sole-proprietorship type and operate in the town in which they live, altho occasionally an independent dealer may own and operate warehouses in two or three towns close together. The method of operation is quite similar to that of the co-operatives. As a rule, independent buyers are better informed in the matter of selling than the managers of co-operatives—their very existence depends upon the margins obtained. This is shown by the fact that they sell a greater proportion of their product direct to jobbers and large retail buyers than do the co-operatives.

The large central market wholesalers or line-house organizations have been in the past the most important agencies in the marketing of Minnesota potatoes. Their central offices are in Minneapolis and St. Paul, and they own or rent a line of country warehouses. Their chief business function is to buy potatoes in the country and ship them in carlots to a consuming center. They use their warehouses in the Twin Cities mostly for reconditioning, but to a limited extent for storing for local consumption. Their volumes of business range from less than 500 to 2500 cars annually. They all purchase potatoes in carlots from other local shippers, as well as handle the purchases made

through their own warehouses. Some do a limited jobbing business in the Twin Cities, but the largest ones confine their efforts to outside shipments. Their sales are for the most part made through outside brokers or to special customers. The line houses have a decided advantage over the co-operatives and independents in the matter of selling. With a large volume of business under one general management, they are able to advertise their product, make special connections in the consuming centers, and thus sell to better advantage. Many of them have a large list of special customers upon whom they can depend for an outlet. They are also better acquainted with the trade, and are less likely to suffer losses from dealing with unreliable buyers. From their central offices in the Twin Cities, they are able to inspect all cars en route to consuming centers, and thus dispose of the various grades to the best advantage.

MEASURES OF SUCCESS

The principal measure of success of a potato warehouse is the price it is able to pay to the grower. To be sure, the owners of proprietory warehouses of the line or independent type are interested more in their margins than in the prices they pay the growers; but this is mostly only in the first instance, for unless they pay the growers reasonably well, they will not continue to receive their potatoes.

The price a warehouse is able to pay the growers depends upon the cost per hundredweight for handling potatoes and the amount and quality of service rendered. It is possible for most marketing agencies greatly to reduce their costs per unit by lowering the quality of their service, but it seldom pays to do this. Two cents per hundredweight saved by a local warehouse by hasty sorting and grading, careless loading, or reckless selling, might cost the warehouse or the growers five times that amount in prices. This bulletin is almost entirely a study of costs, quality of service being largely omitted, not because unimportant but because it is difficult to measure—in fact, is ordinarily impossible to measure it by the crude methods of survey.

Another measure of success of a local potato warehouse is the convenience of the service it offers to growers in the matter of unloading potatoes, handling the crop as fast as delivered, and providing storage if desired. It will be noted later that warehouses differ greatly in these respects and costs accordingly. No doubt much of this extra convenience and service is well worth its extra cost; but perhaps some of it is not.

No doubt, also, a local warehouse can be of considerable service to a potato-growing community in an educational way by assisting growers to obtain good seed stock, encouraging standardization of

sorting methods, and the like. A warehouse organization that undertakes such a program may earn a cent or two per hundredweight in extra costs several times over.

CLASSIFICATION OF COSTS

Table I shows the classification of costs used in this analysis. It should be noted that commissions paid to brokers and exchanges, inspection fees, messenger service, demurrage charges, and other central market and transportation charges are not included, as they are not costs of a local warehouse. A further reason for not including these costs is that the records of most of the warehouses were very incomplete for such costs. For example, the account sales returned by the old Minnesota Potato Exchange did not itemize deductions in such a way as to show these various costs separately from deductions for other reasons. It is recognized, of course, that some warehouses did more direct and on-track selling than others and that for this reason, omitting central market commissions and the like, puts them on an equal basis; but as much allowance for this as possible will be made in the proper place in the analysis.

The largest item in costs is Other Direct Costs, representing 28.8 per cent of the total. This consists, however, almost entirely of sacks, tags, and twine. Office and Management represents 26.7 per cent, and Labor, 24.7 per cent.

Further discussion of what is included under each of the five elementary costs will be found under these heads later in the bulletin.

The costs given have to do with potatoes only. Only four of the warehouses handled sidelines, and it was thought best to omit all sideline costs.

The proportions which the various costs are of the total are given separately for each of the three types of warehouses. These proportions vary greatly, the reasons for which will be discussed later.

In the lower half of the table, elementary costs are represented as distributed to seven process costs, and two other items: sacks, tags, and twine; and miscellaneous. This distribution to processes is upon an arbitrary basis for the most part, and hence is not at all accurate; however, it gives a rough general impression of the relative importance of the different processes.

BUILDING AND SITE

Building and site cost, according to Table I, represents 13.1 per cent of the total local costs of potato warehouses, as compared with 24.7 per cent for labor, and 6.7 per cent for equipment. As will appear later, the range in this cost is very great, therefore it is worth while to analyze the variations very carefully.

As between building cost and site cost, the latter represents only 2.1 per cent of the two combined. Hence no further attention will be given to it.

The elements in building and site cost for the 59 warehouses which were owned by those operating them are indicated in Table II. Interest is the largest item, and depreciation next. Combined, these two represent more than two thirds of the total. These various elements of cost were determined as follows:

TABLE I

CLASSIFICATION OF POTATO WAREHOUSE COSTS BY TYPES OF WAREHOUSES

Cost	Line (33)		Co-operative (26)		Independent (12)		All (71)	
	Per warehouse	Per cent of total	Per warehouse	Per cent of total	Per warehouse	Per cent of total	Per warehouse	Per cent of total
Elementary costs								
Labor	$696	19.2	$1512	27.0	$1940	29.5	$1205	24.7
Building and site	425	11.7	870	15.6	725	11.0	638	13.1
Equipment	209	5.8	441	7.9	412	6.3	328	6.7
Office and management	1554	42.9	966	16.2	1333	20.3	1300	26.6
Other direct costs	762	20.4	1860	33.3	2207	32.9	1409	28.9
Total	$3646	100.0	$5649	100.0	$6617	100.0	$4880	100.0
Process costs								
Buying	$544	14.9	$365	4.7	$403	6.1	$418	8.6
Receiving	90	2.5	290	5.1	288	4.3	196	4.0
Grading	338	9.3	711	12.6	666	10.1	530	10.9
Sacking	309	8.5	628	11.1	755	11.4	501	10.3
Warehousing	712	19.5	1300	23.0	1410	21.3	1046	21.4
Loading cars	144	3.9	280	5.0	365	5.5	230	4.7
Selling	819	22.5	419	7.4	660	10.0	645	13.2
Sacks, tags, and twine	678	18.6	1753	31.0	2060	31.1	1306	26.7
Miscellaneous	12	0.3	3	0.1	10	0.2	8	0.2
Total	$3646	100.0	$5649	100.0	$6617	100.0	$4880	100.0

TABLE II

ELEMENTS OF BUILDING AND SITE COST, 59 OWNER-OPERATED WAREHOUSES

Cost	Line (26)		Co-operative (23)		Independent (10)		All (59)	
	Per warehouse	Per cent of total	Per warehouse	Per cent of total	Per warehouse	Per cent of total	Per warehouse	Per cent of total
Interest	$349	37.4	$317	39.6	$196	41.8	$276	39.1
Depreciation	339	36.3	286	35.7	157	33.6	230	35.4
Insurance	54	5.8	55	6.9	31	6.6	44	6.2
Taxes	140	15.0	96	12.0	69	14.9	102	14.4
Site rent	16	1.7	19	2.3	11	2.4	14	2.1
Miscellaneous	35	3.8	28	3.5	3	0.7	20	2.8
Total	$933	100.0	$801	100.0	$467	100.0	$706	100.0

Interest.—Interest was reckoned on the basis of original cost depreciated to date. In most cases original cost was cost of construction, but in a few cases it was the purchase price of a second-hand warehouse. The prices paid for second-hand warehouses were usually relatively low. The rate of interest used was 6 per cent, except for funds used to build or purchase which had been borrowed at other rates, as will appear later.

Depreciation.—The depreciation rate for frame buildings was usually 5 per cent, and for brick, concrete, or tile buildings, 3 or 4 per cent. It was based on cost of construction except that purchase price was used for the few buildings bought second-hand for which cost of construction could not be ascertained. As will appear later, this method of calculating depreciation introduced some undesirable variations into the results.

Insurance.—As paid.

Taxes.—As paid, not including any income taxes.

Site rent.—As paid, in most cases. Sites were usually rented from railway companies.

Miscellaneous.—Includes repair items mostly.

Fuel cost was not included with building cost because it does not vary as do building costs proper. There is no relation between variations in interest, depreciation, insurance, and taxes, and variations in fuel cost. Hence, to include fuel cost with building cost simply confuses the variations in building cost which it is desired to analyze.

Twelve warehouses were rented. The average rent paid by seven line houses was $255, by three co-operatives, $402, and by two independents, $509—an average of $334 for the twelve, which is less than half the annual cost of the owner-operated warehouses. The reason for this is partly that they are smaller, but more largely that they are located at shipping points with too many warehouses. In many cases the owners were glad to take a low rental rather than to operate them at a probable loss. The average annual building and site cost for owned and rented warehouses combined was as follows: line houses, $422; co-operatives, $871; independents, $752; all combined, $642.

METHOD OF ANALYSIS

Building cost per warehouse, under the method of calculating interest and depreciation herein used, will vary with age of building, type of construction, and size and plan of building. Building cost per hundredweight of potatoes handled will vary also with the volume of business handled, that is, with utilization. A careful analysis of building cost per hundredweight would reduce it to two factors, namely, annual cost of building per square (or cubic) foot, and hundredweight of

potatoes handled per square (or cubic) foot. Thus if a given warehouse handled 10 hundredweight of potatoes per square foot of floor space, and each square foot cost 25 cents a year, its hundredweight costs are 25 cents divided by 10, or 2.5 cents. The square foot is the better unit for comparing handling capacity, and the cubic foot for handling storage capacity. Storage space is usually in the basement. Building costs for the basement and ground floor could have been roughly separated if the survey had been planned in advance on this basis. As it was not, the best that could be done was to consider all building costs on a square-foot basis.

COST PER WAREHOUSE

Under the methods used, the most important factor in annual cost per warehouse is the original cost of construction. Table III gives the range in cost of construction for fifty warehouses on this basis. These data and those following can not be used in the form here given as guides in planning warehouse construction, as they have not been adjusted for changes in price and costs of construction. This introduces a serious error, as during the period represented, costs of material and labor more than doubled. Ten of them cost less than $2000, nine $10,000 or more, and five, from $15,000 to $17,000. The fourteen frame buildings without basements cost on an average only $2584, and the twenty-three frame buildings with basements $6503. The five built of masonry (brick, concrete, or tile) without basements cost $3920, and the eight built of masonry with basements, $9529.

TABLE III

RANGE IN ORIGINAL COSTS OF 50 WAREHOUSES

Cost groups	No. in group	Average cost
Under $2000	10	$1,340
2000 to 4000	12	2,856
4000 to 6000	10	4,625
6000 to 8000	6	6,733
8000 to 10,000	3	8,619
Over 10,000	9	13,488
All	50	$5,631

Table IV gives the range in size in terms of square feet of floor space on the ground floor. The average was 2753 square feet, and the ordinary range from 1000 to 4000 square feet. Size is the most important factor in total cost, but not in unit cost.

TABLE IV

RANGE IN SIZE OF WAREHOUSES IN SQUARE FEET OF GROUND FLOOR SPACE

Size in floor space	No. in group	Average size
Square feet		Square feet
1000 to 1500	9	1297
1500 to 2000	12	1722
2000 to 2500	12	2268
2500 to 3000	7	2688
3000 to 3500	18	3234
3500 to 4000	5	3646
4000 to 4500	4	4186
4500 to 5000	2	4680
Over 5000	2	6900
All	71	2753

The frame buildings without basements averaged 2714 square feet, and cost 95 cents per square foot. The frame buildings with basements averaged 2894 square feet, and cost $2.25 per square foot. The masonry buildings without basements averaged 3144 square feet, and cost $1.25 per square foot. The masonry buildings with basements averaged 3532 square feet, and cost $2.70 per square foot. Thus the addition of basement storage added 137 per cent to the cost per square foot of frame buildings, and 116 per cent to the cost per square foot of masonry buildings. This addition is largely accounted for by the fact that the buildings with basements are of more recent construction and were built at higher cost levels. As already indicated, none of these averages is at all accurate, because they represent buildings erected at greatly differing price levels. Exactly how much of the higher costs of masonry buildings and buildings with basements and of the larger buildings is due to their being newer, cannot be stated, but undoubtedly an appreciable part of it.

TABLE V

RELATION OF CONSTRUCTION COST PER SQUARE FOOT TO DATE OF BUILDING FOR TWENTY-FIVE CO-OPERATIVE WAREHOUSES

Year of construction	No.	Average size	Average cost	Average cost per sq. ft.
		Square feet		
1916-17	4	2348	$3300	$1.47
1918	4	2775	8825	2.39
1919	5	3961	9824	2.48*
1920-21	12	2421	6456	2.67*
All	25	2774	$6652	$2.39

* Twelve of the houses built in 1919-20 were of frame construction with basements and the average cost was $2.64 per square foot.

Because of this error, it was believed unwise to try to compare the costs of brick, tile, and cement warehouses, and the effect of size and shape of building on the cost per square foot.

The average purchase price of second-hand buildings was 88 per cent of the value of new buildings of the same type depreciated to the same extent. Usually the owners of these buildings had been glad to sell them because they were unprofitable. In computing annual cost per warehouse, the original cost was divided by the estimated life to get the depreciation per year. The higher the original costs, probable life being the same, the higher the depreciation charge. Depreciation figured by this method depends upon the price level at time of construction as well as upon type of construction. Interest was based upon original cost less depreciation to date—the longer the warehouse had been built, the less its interest charge.[2] Taxes and insurance are roughly proportional to present valuation. The extreme range in annual costs per warehouse was from $90 to $2300, and the ordinary range from $200 to $1500. Table VI gives the range in detail. The ordinary range for rented warehouses was from $200 to $500.

TABLE VI

RANGE IN ANNUAL BUILDING COST PER WAREHOUSE IN RELATION TO COST PER SQUARE FOOT OF FLOOR SPACE

Cost groups	Number in group	Cost per square foot	Cost per warehouse	Square feet per warehouse
		Cents		
Under $200	8	5.5	$144	2640
200 to 400	20	12.8	287	2238
400 to 600	15	22.2	518	2335
600 to 800	10	22.7	674	2970
800 to 1000	6	32.0	901	2810
1000 to 1500	6	36.8	1240	3367
1500 and over	6	39.2	1787	4563
All	71	23.1	$642	2753

Table VII gives the comparative figures for line, independent, and co-operative warehouses. The line companies rented a larger proportion of their warehouses, and at a lower rent, than did the co-operatives or the independents. Only 18 per cent of the co-operatives were of masonry construction, as compared with 20 per cent for line houses and 25 per cent for independents. Only 67 per cent of the co-operative warehouses had basements as compared with 70 per cent of the line houses and 58 per cent of the independents. However, the co-operative and independent warehouses were much newer than the line houses,

[2] The effect of using this method is to produce large variations in annual cost. If the sample is large enough, and representative, the average for the lot may be nearly correct; but the costs for individual warehouses unless they can be corrected for these variables will vary so much that the effects of the variations to be studied, such as those due to type of construction, size of buildings, rate of depreciation, and the like, are largely obscured. The proper method of handling interest charge for such a study is to apply the rate to one half the original cost (which gives the average investment for the life of the building), and reduce the original costs to a common price level, preferably the existing one.

especially the co-operatives. To the extent that this is true, the lower costs shown for the line houses are misleading for reasons already given. After making allowance for this error, however, a considerable difference will remain. We shall see later whether the larger and more expensive warehouses of the co-operatives are justified by a larger volume of business.

TABLE VII
WAREHOUSE COSTS BY CLASSES OF ENTERPRISES

	Line	Co-operative	Independent	All
Owned buildings				
No.	26	23	10	59
Original cost	$3972	$7208	$6800	$5978
Square feet ground floor space	2829	3107	2286	2845
Original cost per square foot	$1.40	$2.32	$2.97	$2.10
Annual cost	$467	$933	$801	$705
Rented buildings				
No.	7	3	2	12
Square feet ground floor space	1971	1933	2850	2141
Rental cost	$255	$402	$509	$334
Annual cost, all buildings	$422	$871	$752	$638
Annual cost per sq. ft.	0.16	0.29	0.27	0.23

Figure 2 shows the relation between volume of business and annual cost per warehouse. For the warehouses handling 10,000 hundredweight, the annual building cost averaged around $500; for those handling 50,000 hundredweight, around $1300. Thus building cost increases much more slowly than volume of business. The reasons for this will be explained later.

ANNUAL COSTS PER SQUARE FOOT

Annual costs per warehouse must be reduced to a square-foot basis before they can be combined with data on utilization of space to give a complete explanation of variations in hundredweight costs. Table VIII shows the range in annual cost per square foot. If utilization of space were alike in all warehouses, cost per square foot alone would produce an ordinary variation of about 160 per cent of the average warehouse cost per hundredweight of potatoes handled ($0.23).[3] This table does not separate warehouses with and without basements. The ordinary range for those with basements was 10 to 60 cents; for those without basements, from 6 to 30 cents. The average for warehouses with basements is 27.2 cents; for those without basements, 14.2 cents. The average for line houses is 15.9 cents; for co-operatives, 29.4 cents; and for independents, 26.6 cents.

[3] Partly due to error in method already explained. The range would be greatly reduced if interest and depreciation had been computed on a comparable basis.

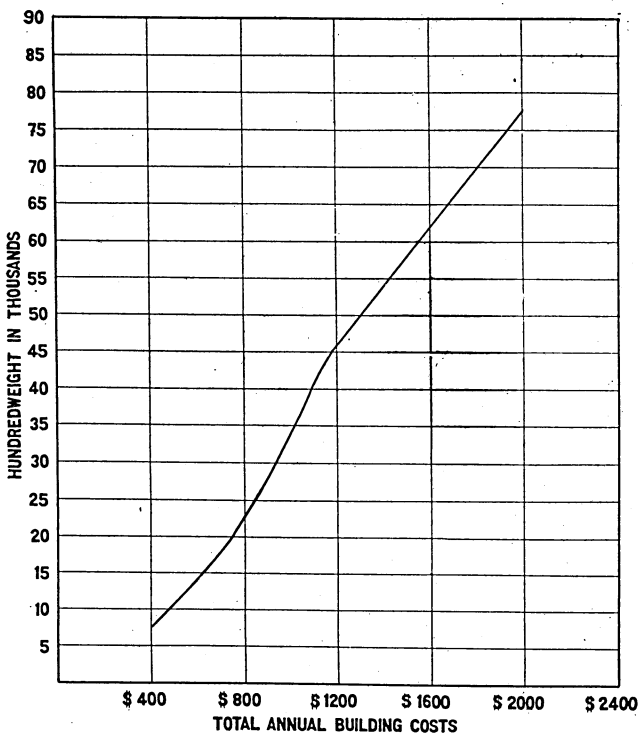

Fig. 2. Building Cost per Warehouse, Increasing with Volume of Business

TABLE VIII

RANGE IN ANNUAL BUILDING COSTS PER SQUARE FOOT OF FLOOR SPACE

Groups—cents per square foot	No. in group	Cost per square foot	Square feet per warehouse	Cos per warehouse
		Cents		
Under 10	9	5.4	3155	$171
10 to 15	13	12.1	2643	332
15 to 20	12	16.3	2584	423
20 to 30	14	24.2	2853	690
30 to 40	13	33.5	2495	837
40 to 50	9	45.9	2852	1311
Over 50	1	51.1	3600	1840
All	71	23.1	2753	638

It is interesting to note at this point a certain relation between annual building costs per square foot and volume of business. Figure 3 shows, for example, that warehouses handling only 20,000 hundredweight had costs of only 26 cents per square foot as compared with 50 cents for those handling 60,000 hundredweight. This looks peculiar at first, and is indeed largely fictitious, because the warehouses handling the larger volume of business are newer, larger, and of better construction.

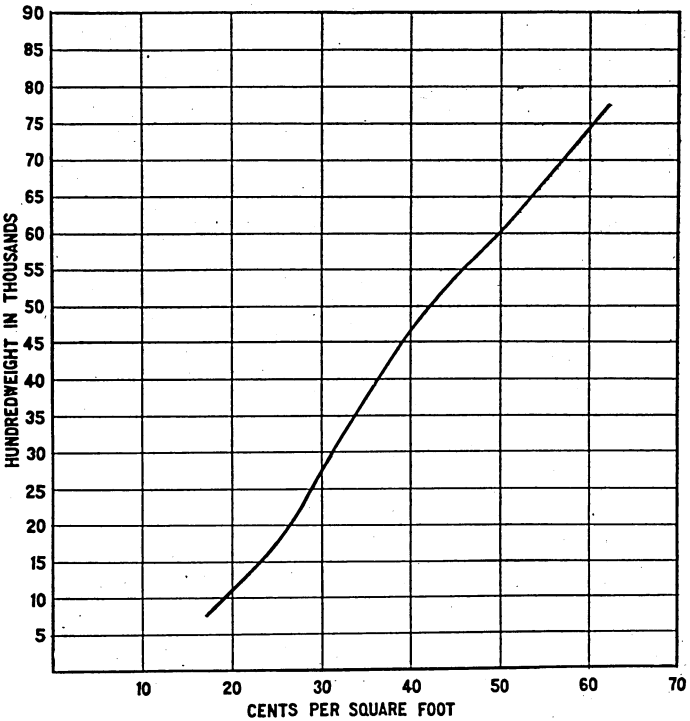

Fig. 3. Annual Building Cost per Square Foot, Increasing with Volume of Business

This increase is largely due to the fact that the larger warehouses were built more recently and at higher price levels.

UTILIZATION: HUNDREDWEIGHT PER SQUARE FOOT

Utilization of space in a warehouse is about equivalent in meaning to turnover of stock. It may be expressed either in terms of hundredweight per square foot or of square feet per hundredweight or carload. One is simply the reciprocal of the other. In this analysis it will be expressed in both ways. Table IX gives the range in size of warehouse. The range is rather wide, 8 of the houses being more than three times as large as the 21 smallest houses. Table X gives the range in volume of business handled. There were 21 at one extreme which averaged 7215 hundredweight and ten at the other extreme which averaged 57,642 hundredweight. The line houses handled less than half as many hundredweight as the co-operatives and independents. With these wide ranges in size of warehouses and volume handled, there is sure to be a very wide range in utilization, or hundredweight per square foot, as is indicated by Table XI. The best utilizations are more than five times as good as the poorest ones. Ten line houses handled less than 3 hundredweight per square foot of floor space, and

5 independents over 15 hundredweight per square foot. The range is about 175 per cent of the average.

TABLE IX

RANGE IN SIZE OF WAREHOUSES IN SQUARE FEET OF FLOOR SPACE

Groups	No. in group	Average size of group	Cost per per warehouse	Cost per square foot
Square feet				Cents
Under 1500	9	1265	$311	24.5
1500 to 2000	12	1720	448	27.0
2000 to 2500	12	2270	442	19.5
2500 to 3000	7	2690	623	23.2
3000 to 3500	18	3240	757	23.4
3500 to 4000	5	3650	938	25.7
4000 to 5000	5	4350	1060	24.3
Over 5000	3	6380	1176	18.4
All	71	2753	$637	23.1

TABLE X

RANGE IN VOLUME OF BUSINESS IN HUNDREDWEIGHTS, BY CLASSES OF WAREHOUSES

Group (000's omitted)	Line		Co-operative		Independent		All	
	No. in group	Average volume	No. in group	Average volume	No. in group	Average volume	No. in group	Average volume
		Cwt.		Cwt.		Cwt.		Cwt.
Under 10	14	7,151	5	7,631	2	6,606	21	7,215
10 to 15	10	11,767	5	11,555	2	14,164	17	11,986
15 to 20	6	17,014	4	18,326	0	0	10	17,548
20 to 40	3	23,043	6	26,408	4	29,270	13	26,512
Over 40	0	0	6	61,167	4	52,357	10	57,642
All	33	11,792	26	26,718	12	30,670	71	20,449

TABLE XI

RANGE IN UTILIZATION OF FLOOR SPACE, 71 WAREHOUSES

Hundredweight per square foot	Line	Co-operative	Independent	All combined
Under 3	10	0	0	10
3 to 6	14	10	4	28
6 to 9	3	5	1	9
9 to 12	4	4	0	8
12 to 15	2	3	2	7
15 and over	0	4	5	9
All	33	26	12	71

The average for all warehouses is 7.4 hundredweight per square foot. Table XII also compares utilization by classes of warehouses. The line houses are not only smaller, but have a much lower rate of turnover.

TABLE XII
UTILIZATION BY CLASSES OF WAREHOUSES

	Average floor space	Average volume	Utilization	
			Cwt. per sq. ft.	Sq. ft. per cwt.
	Sq. ft.	Cwt.		
Line	2639	11.792	4.5	0.22
Co-operative	2802	26.718	9.5	0.11
Independents	2866	30.670	10.7	0.09
All	2753	20.449	7.4	0.14

Figure 4 shows graphically the general relationship between volume of business and size of warehouses. Floor space on the ground floor ranges only from 2400 square feet for a volume of 7500 hundredweight, to 3280 square feet for a volume of 87,500 hundredweight.

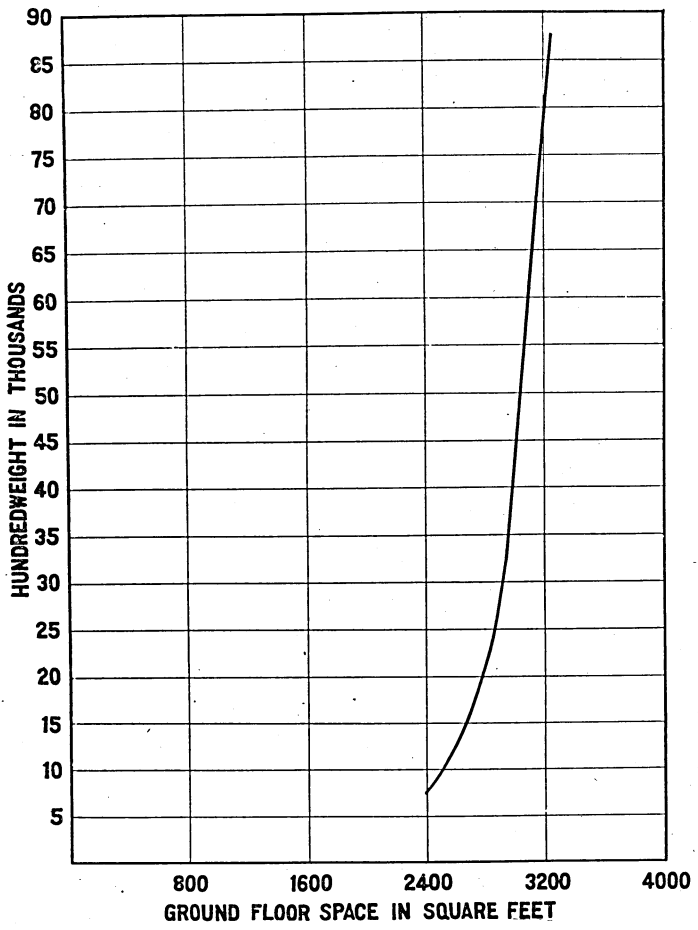

Fig. 4. Ground-Floor Space Increasing with Volume of Business

This change is only at the average rate of 110 square feet additional for each 10,000 additional volume of business. Below 20,000 the change is at the rate of 300 square feet for each additional 10,000 hundredweight in volume, but even this is a relatively small increase; in fact, only a 17 per cent increase in size for a 185 per cent increase in volume. Figure 5 shows the same data reduced to the basis of square feet per carload (360 hundredweight) of volume. At the 10,000-hundredweight volume, 90 square feet of floor space were used for each carload of output; at the 87,500-volume, 10 square feet. This is a decrease of 10.3 square feet per carload, or 18 per cent of the average, for each 10,000 increase in volume. It is thus the variations in volume handled rather than in "size of warehouses" that is principally responsible for difference in utilization. If size of building increases slowly with volume, then utilization must increase rapidly. The increase is much more rapid under 30,000 than above that point, because very few warehouses are built small enough to give good utilization with a volume under 30,000.

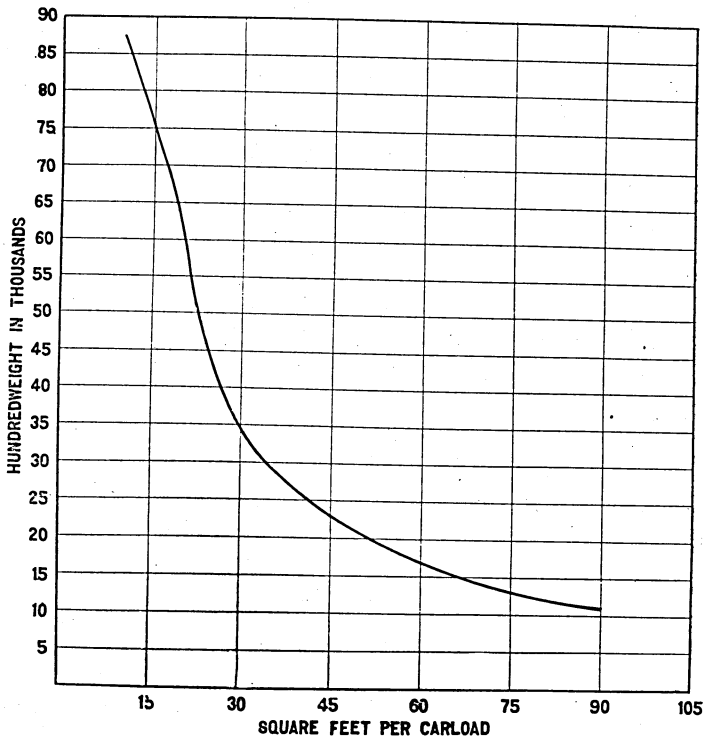

Fig. 5. Large Volume Gives Better Utilization of Ground-Floor Space

The maladjustment between volume of business and size of warehouse seems to be of two sorts: first, a large number of warehouses that were under-utilized and perhaps a few that were over-utilized—as indicated by the slow increase in size of warehouse with volume; second, wide variations in volume within each size group, as indicated in Table XIII, which gives the high and low volumes for each group. Several explanations may be offered for this maladjustment. (1) The figures on volume of business are for 1921, in which production was somewhat below normal. This will partly account for the small volume for the warehouses in general. (2) Some of the warehouses were built many years ago in areas where increased competition and changes in type of farming have decreased the volume which any warehouse can expect to obtain. This explanation especially fits the line houses, which have the poorest utilization. It is in agreement with the opinions of several of the wholesale dealers with whom the matter was discussed. Wherever, in a group of any size, a warehouse is found with very poor utilization this is likely to be the cause.

TABLE XIII

RELATION OF SIZE OF WAREHOUSE TO RANGE IN VOLUME

Square feet (00's omitted)	Volume of business—hundredweights							
	Co-operative		Line		Independent		All	
	High	Low	High	Low	High	Low	High	Low
10 to 15	16,881	8,071	15,954	7,314	21,240	4,500	21,240	4,500
15 to 20	11,654	5,045	24,486	4,718	8,712	8,712	24,486	4,718
20 to 25	13,580	11,160	20,571	5,025	31,040	31,040	31,040	5,025
25 to 30	41,337	21,600	16,560	7,950	37,800	37,800	41,337	7,950
30 to 35	87,205	18,324	24,073	4,499	63,360	13,329	87,205	4,499
35 to 40	64,390	11,345	9,921	9,921	44,703	44,703	64,390	9,921
40 to 45	21,670	18,332	18,051	18,031	27,000	27,000	27,000	18,031
45 to 50	63,781	63,781	10,512	10,512	.....	.....	63,781	10,512
Over 50	66,608	66,608	12,081	12,081	.....	.....	66,608	12,081
All	87,205	5,045	24,486	4,499	63,360	4,500	87,205	4,499

A third explanation is that some of the warehouses were built large to provide storage space. This is supported by the fact that in general the warehouses with basements are larger than those without basements.

The average storage capacity of line houses was 8035 hundredweight; of co-operatives, 8664 hundredweight; and of independents, 8427 hundredweight. The turnover for storage capacity was as follows: line houses, 0.69 time; co-operatives, 0.89 time; independents, 0.81 time; all combined, 0.79 time. Table XIV shows that storage capacity per square foot of floor space is almost constant for warehouses of different sizes. Therefore the warehouses with a large basement for storage have extra space on the main floor and have poorer utilization of it. Table XIV also shows that the larger warehouses have a lower turnover of storage capacity.

TABLE XIV

RELATION OF FLOOR SPACE TO STORAGE CAPACITY

Size	No. in group	Average floor space	Average storage capacity	Storage capacity per squart foot of floor space
Sq. ft.		Sq. ft.	Cwt.	Cwt.
1000 to 1500	9	1265	3,780	2.98
1500 to 2000	12	1720	4,867	2.82
2000 to 2500	12	2270	6,912	3.04
2500 to 3000	7	2690	8,294	3.08
3000 to 3500	18	3240	9,792	3.02
3500 to 4000	5	3650	11,404	3.12
4000 to 4500	3	4467	13,132	2.93
4500 to 5000	2	4680	14,400	3.07
Over 5000	3	6380	21,772	3.41
All	71	2753	8,332*	3.02

* The average for the co-operatives is 8664; for the line houses, 8035; and for the independents, 8427 hundredweight.

The line houses, even tho smaller, did not utilize their storage capacity as well as did the others, because the volume of potatoes handled was so much smaller. However, the ratio of potatoes stored to potatoes handled was: line houses, 0.47; co-operatives, 0.29; independents, 0.22; and for all combined, 0.32.

COST PER HUNDREDWEIGHT

Table XV shows that the ordinary range in cost per hundredweight is from 3 to 10 cents. A comparison of Tables VIII and XI shows a wider range for utilization than for cost per square foot. Hence utilization is more responsible than cost per square foot for variations in cost per hundredweight. Furthermore, a considerable part of the variations in cost per square foot is due to using methods which did not allow for differences in date of construction. On a comparable basis, utilization would prove to be much the more important of the two factors.

TABLE XV

RANGE IN BUILDING AND SITE COST PER HUNDREDWEIGHT, BY CLASSES OF WAREHOUSES

Cost	No. in each group			
	Line	Co-operative	Independent	All
Cents				
Under 3	11	6	4	21
3 to 5	13	13	4	30
5 to 7	6	3	1	10
7 to 10	2	4	0	6
10 and over	1	..	3	4
All	33	26	12	71

In planning a new warehouse, therefore, more attention needs to be given to building the right size of warehouse than to type and cost of construction, altho both are important. It will not be possible in this analysis to go into the question of the cost of maintaining large storage capacity and the advantages of it, but these should be carefully considered. Adding a basement, of course, adds to the cost per square foot of floor space; and there also seems to be a tendency to build warehouses large in order to provide storage space, and this decreases the turnover both of floor space and of storage space.

The effect of utilization is made further apparent when the relation of volume of business to cost is studied. Figure 2, previously referred to, shows this relationship on a warehouse basis. Figure 6 shows this relationship expressed in terms of cost per hundredweight. At 10,000 hundredweight, the average cost is about 4.7 cents per hundredweight; at 20,000, around 3.7 cents; at 40,000, around 2.7 cents; and above 50,000, practically constant at 2.6 cents. Above 50,000 hundredweight, however, the curve is based on too few cases to make it very dependable. Under 50,000 hundredweight, the decrease in building and site cost is at an average rate of about 0.8 cents for each 10,000 increase in volume.

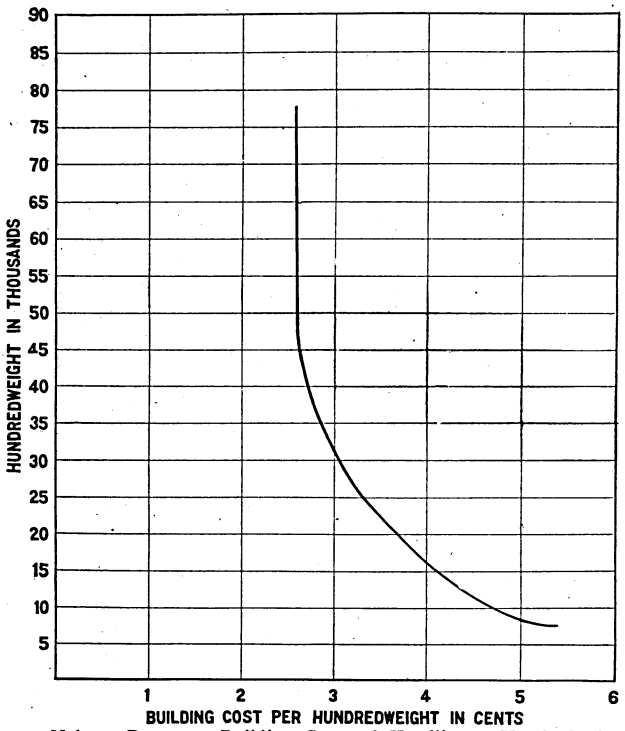

Fig. 6. Large Volume Decreases Building Costs of Handling a Hundredweight of Potatoes

It will be recognized at once that the curve in Figure 6 is a combination of the curve in Figure 3 (showing a considerable increase in costs per square foot with volume) and Figure 5 showing a very pronounced decrease in floor space used per carload.[4] The decrease in space used thus more than offsets the increases in cost per square foot under 50,000 hundredweight, and almost exactly offsets it above 50,000 hundredweight. Between 20,000 and 50,000 hundredweight, costs per square foot are about doubled, and square feet per carload are cut in four. It will be remembered that most of the increases in utilization occurred under 50,000 hundredweight.

If, as already explained, interest and depreciation had been figured in a comparable loss, a considerable part of the increase in cost per square foot with output would have disappeared. Building and site cost would then have decreased with volume more like the utilization curve in Figure 5.

Table XVI shows the relation of volume of business to cost per hundredweight, and also gives the high and low costs for each volume group. This makes it clear that altho volume of business is an important factor there are other factors of still greater importance. Thus, in the group of 17 warehouses handling less than 10,000 hundredweight, one had costs as high as 16 cents per hundredweight, and another as low as one cent. If we examine a number of individual warehouses we will probably discover some of these other causes.

TABLE XVI

RELATION OF BUILDING AND SITE COST PER HUNDREDWEIGHT TO VOLUME OF BUSINESS IN SEVENTY-ONE WAREHOUSES

Hundredweights (000's omitted)	No. in group	Building and site cost per cwt.		
		High	Low	Average
		Cents	Cents	Cents
Under 10	21	16	1	4.76
10 to 15	17	12	1	4.31
15 to 20	10	10	1	3.46
20 to 40	13	8	1	3.02
40 or over	10	4	1	2.18
All	71	16	1	3.08

No. 39, an independent handling only 40 cars, has a 36x96 hollow-tile warehouse, with basement, that cost $15,000, including a $3000 track extension. The building is about 800 square feet, or 20 square feet per carload, larger than the average for this volume of business, but the major factor is cost per square foot, which is 4.9 cents per square foot of space as compared with the average of 2.1 cents for this

[4] A carload was considered as 360 hundredweight. The shape of the curve is the same with carloads or hundredweights as the unit.

volume of business. The effect of the combination of high costs and poor utilization is to give building costs of 11.7 cents per hundredweight, as compared with an average of 3.08 cents for the 71 warehouses. Unless volume of business can be increased, this warehouse is too large; and probably, also, of too expensive construction. To make the latter statement, however, further information is needed, such as the certainty of potato-growing in the district, the certainty of success of the warehouse, and the attitude of the growers.

It should be pointed out here that high first costs do not necessarily mean high annual costs. If hollow-tile buildings last enough longer to offset the higher interest charge on the investment, then high first costs will lower the annual costs. It is always a nice point to determine what grade of construction is most profitable in the end. The more expensive the construction, the higher the interest cost and the larger the amount to divide into the life of the building; but the longer the life, the more years into which to divide it. Potato warehouses, however, tend to become obsolescent for various reasons, so that too long a period of use can not be considered with safety.

No. 55 is a line house built in 1898 of frame construction, without basement, insured for $800. It handled 30 cars at a handling cost of 0.8 cent per hundredweight.

No. 39 was a new warehouse, No. 55 an old one. If both had been built the same year, or costs had been reckoned on a comparable basis, their costs would have been much more nearly equal, but still significantly different because of differences in type of construction. Furthermore, this warehouse used only 37 square feet of floor space per carload as compared with an average of 90 for other warehouses with the same volume.

No. 30, a co-operative, has a frame warehouse 36x96 built over a cement basement, which cost $11,400. It handled 230 cars in 1921 at a building cost of 1.96 cents per hundredweight. The building cost per square foot is over twice the average, but the volume of business is so large that cost per hundredweight is relatively low.

No. 22, a co-operative warehouse which handled 112 cars in 1921, has a frame 40x80 one-story warehouse that cost $4000 in 1916. Its building costs were 1.2 cents per hundredweight, as compared with 2.7 cents for other warehouses with the same volume. Its building costs per square foot are 17.8 cents, about half the average for this volume; and its utilization, 28.6 square feet per carload, about the same as the average for the volume. The low costs are therefore due to lower costs per square foot.

Table XVII shows that line houses have the highest building costs per hundredweight, even tho their costs per square foot are very low,

because of very poor utilization. Building costs of independent houses are lower than those of co-operatives because costs per square foot are lower and utilization is better.

TABLE XVII

COMPONENTS OF BUILDING AND SITE COST BY CLASSES OF WAREHOUSES

	Cost per sq. ft.	Sq. ft. per cwt.	Cost per cwt.
	Cents		Cents
Line	.16	0.23	3.61
Co-operative	.29	0.11	3.17
Independents	.28	0.09	2.45
All	.23	0.13	3.08

DISTRIBUTION OF BUILDING COSTS

Table XVIII shows how building costs are distributed to processes. This distribution is based upon estimates and measurements of the proportions and amounts of space used by the various processes. Space between articles of equipment was divided between them in whatever proportion seemed most in keeping with its actual use. In this distribution to processes, $57 of fuel cost has been included, as fuel cost is probably more nearly proportional to space used than to any other simple basis. Where potatoes are stored for considerable periods, a larger proportion, it is true, should be charged to warehousing, but this represents a degree of refinement not attempted in the rest of the analysis.

TABLE XVIII

DISTRIBUTION OF ANNUAL BUILDING COST TO PROCESSES (INCLUDING FUEL)

Process	Line		Co-operative		Independent		All warehouses	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Receiving	$ 4	1.0	$ 46	5.0	$ 17	2.1	$ 22	3.2
Grading	79	16.9	140	15.0	120	14.7	108	15.6
Sacking	65	13.9	127	13.7	118	14.6	97	13.9
Warehousing	317	68.2	618	66.3	557	68.6	468	67.3
Total	$465	100.0	$931	100.0	$812	100.0	$695	100.0

EQUIPMENT COST

Equipment cost, according to Table I, is 6.7 per cent of all costs. It is, then, one of the least important of the elementary costs. Table XIX shows the elements of equipment cost. Depreciation represents about one half the total.[5]

[5] A more correct procedure for handling power cost would have been to set up an intermediate account called "Power," which would have included power equipment cost, power supplies cost, power labor, etc. Power cost thus constituted could be prorated on the basis of power used.

TABLE XIX

ELEMENTS OF EQUIPMENT COSTS

Process	Co-operative		Line		Independent		All warehouses	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Interest	$ 68	15.5	$ 35	16.8	$ 65	15.9	$ 52	16.0
Depreciation	210	47.7	86	41.4	210	51.0	153	46.5
Taxes	27	6.1	15	7.4	22	5.4	21	6.3
Insurance	12	2.7	8	3.7	14	3.5	10	3.2
Repairs	55	12.4	26	12.6	20	4.9	36	10.9
Power supplies	69	15.6	38	18.1	79	19.3	56	17.1
Total	$441	100.0	$208	100.0	$410	100.0	$328	100.0

Depreciation was calculated in the same way as building and site cost. This means that new warehouses have relatively higher depreciation for the same equipment because bought at higher cost levels. Interest was based, as for building and site cost, on original cost depreciated to date. It is therefore high for new warehouses for two reasons, namely, that the new equipment was higher priced, and that it had not depreciated so much. The error thus introduced seriously interferes with such correlations as that between equipment cost per hundredweight and output, and that between equipment cost and labor cost.

Equipment cost can not be analyzed to advantage as an aggregate. It is necessary to consider each item of equipment as a unit. This is best done in connection with the processes using the various items of equipment. Table XX shows the major items of equipment of a potato warehouse, and indicates how generally each is used. In addition, all warehouses are equipped with ordinary platform scales, sack-holders, shovels, and the like. Line houses are much more poorly equipped than the others with wagon dump scales and conveyers.

TABLE XX

NUMBER OF WAREHOUSES, BY CLASSES, HAVING VARIOUS ITEMS OF EQUIPMENT

	Line		Co-operative		Independent		All	
	No.	Per cent of total	No.	Per cent of total	No.	Per cent of total	No.	Per cent of total
Electric motors	23	69.7	13	50.0	6	50.0	42	59.2
Gasoline engines	6	18.2	9	34.6	4	33.3	19	26.7
Both gas and electric	4	12.1	3	11.5	2	16.6	9	12.7
Conveyors	4	12.1	7	27.0	5	41.7	16	22.5
Sack elevators	23	69.7	21	81.0	9	75.0	53	74.7
Wagon scales	4	12.1	1	3.8	0	0.0	5	7.0
Wagon dump scales	3	9.1	18	69.3	10	83.4	31	43.6
Rent wagon scales	5	15.1	1	3.9	0	0.0	6	8.5

Figures 7 and 8, showing the plans of two fairly representative potato warehouses, also indicate the placing of the equipment in each case. There are, of course, a good many variations from these plans.

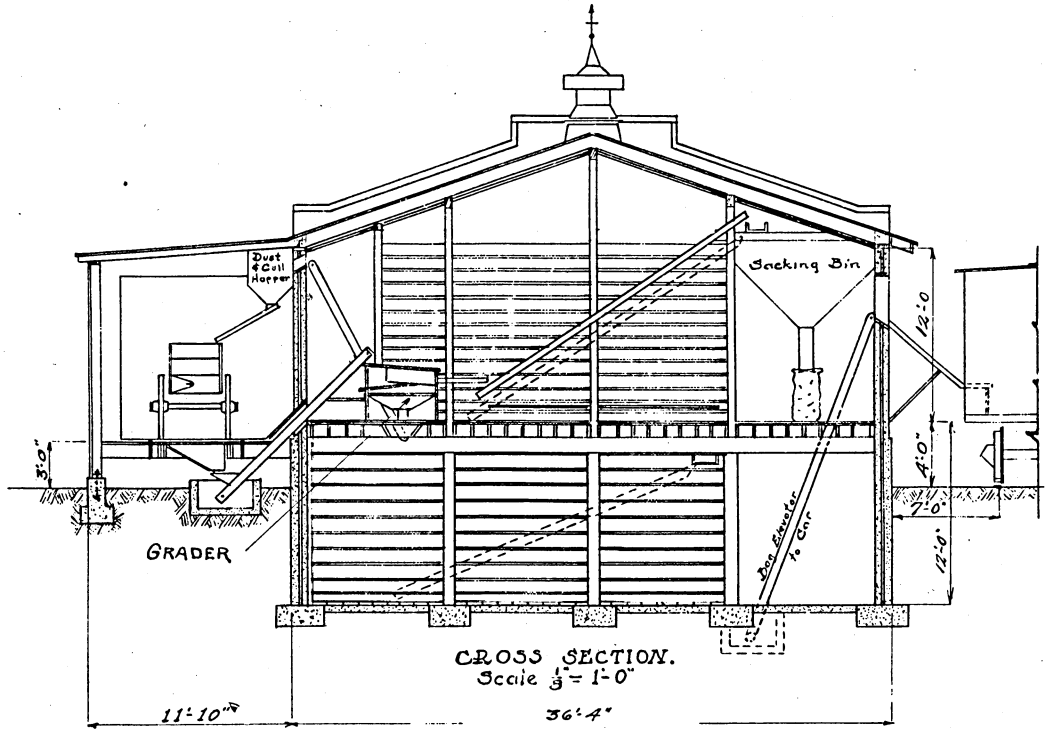

Fig. 7. Cross-Section of Typical Potato Warehouse
(Prepared by the Hickok Construction Company, Minneapolis, Minn.)

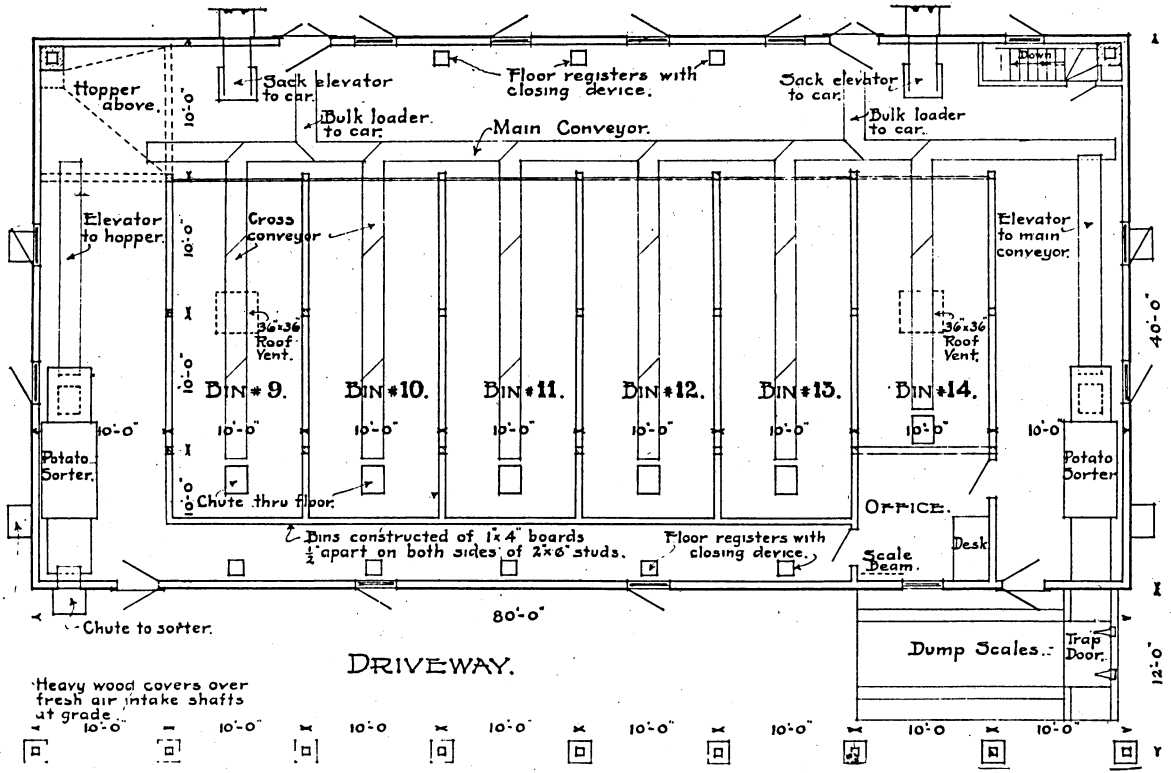

Fig. 8. First-Floor Plan of Typical Potato Warehouse

(Prepared by the Division of Agricultural Engineering, University Farm, St. Paul, Minn.)

Table XXI shows the range in value of equipment per warehouse at the time of the survey. Six of them had less than $300 worth of equipment, and ten of them more than $1500 worth. The variations are due to differences in the amount of equipment per warehouse, also in the age of the equipment, the extent to which it was depreciated at the time of the survey, and the level of prices at the time it was purchased. The average for all warehouses was $821; for line houses, $615; for co-operative houses, $976; and for independents, $1220.

TABLE XXI
RANGE IN VALUE OF EQUIPMENT BY CLASSES OF WAREHOUSES

Value of equipment	No. in group			
	Line	Co-operative	Independent	All
Under $300	0	6	0	6
300 to 600	18	4	2	24
600 to 900	11	5	2	18
900 to 1200	3	3	4	10
1200 to 1500	0	2	1	3
1500 to 1800	0	5	1	6
1800 and over	1	1	2	4
All	33	26	12	71

These figures can not be taken as guides as to the amount which any warehouse should spend for equipment, because prices have changed; because these values are for partly depreciated equipment; and also because the average for a lot of warehouses, many of which are over-equipped or under-equipped, is no safe guide for others to follow. It is well for any warehouse operator to know, however, whether his warehouse is above or below the average, and how far.

Table XXII compares the three classes of warehouses and gives the ratios between equipment values and building values at the time of the survey. These ratios will depend upon the relative depreciation of building and equipment as well as upon amount of equipment and type of construction. The line houses have less equipment. The low ratio for co-operatives is due to the fact that more of the co-operative warehouses are of recent construction. The high ratio for independent houses is a true index of the fact that they are better equipped. The equipment of line houses is about on a par with their buildings.

TABLE XXII
VALUE OF EQUIPMENT BY CLASSES OF WAREHOUSES, RATIO OF EQUIPMENT TO BUILDING VALUE AT TIME OF SURVEY

Classes of warehouses	Value of building	Value of equipment	Ratio of equipment value to building value
			Per cent
Line	$3257	$615	18.8
Co-operative	5920	976	16.5
Independent	5583	1220	21.8
All	$4688	$821	17.5

Figure 9 shows graphically how equipment cost for warehouses varied with volume of potatoes handled for the 71 warehouses covered in the survey. Thus the small warehouses handling from 10,000 to 15,000 hundredweight had average equipment costs around $280, and the warehouses handling 50,000 hundredweight had average equipment costs of around $580. The increase with volume is rather slow under 30,000 hundredweight.

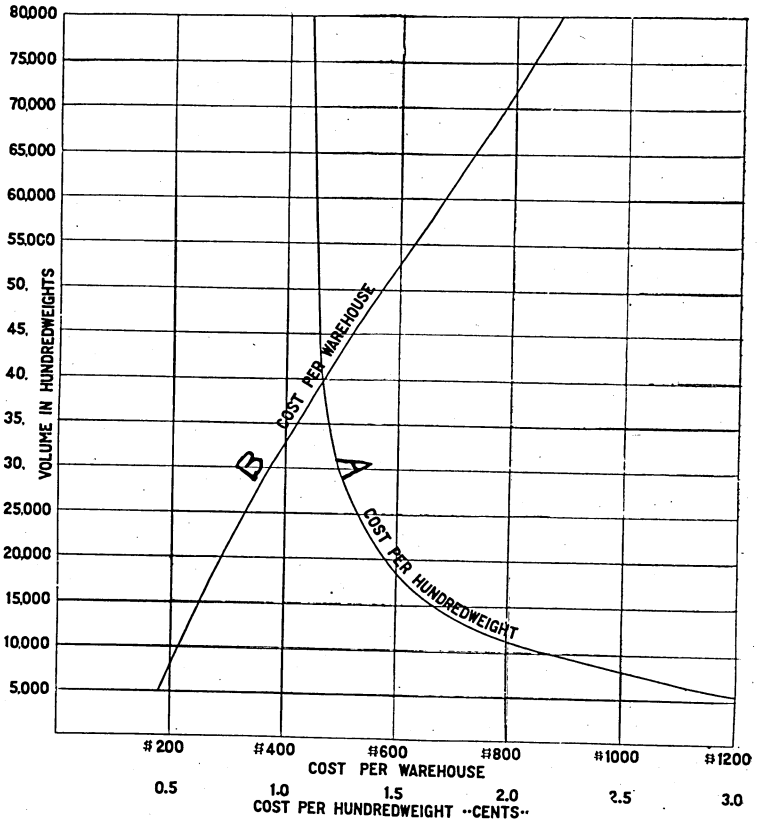

Fig. 9. Relation of Volume of Business to Equipment Costs
Curve A, Equipment Costs per Hundredweight
Curve B, Equipment Costs per Warehouse for Different Volumes

EQUIPMENT COST PER HUNDREDWEIGHT

Table XXIII shows the range when equipment cost is reduced to a hundredweight basis. The range is somewhat wider than for total warehouse equipment costs. Utilization is undoubtedly a large factor in this range, but, as already pointed out, it is not possible to show its effects separately except by analyzing each item of equipment separately, which is best undertaken in connection with the process cost

analysis. Also, as with buildings, if equipment, interest, and depreciation were put on a comparable basis, utilization of equipment would prove more important than cost of equipment.

TABLE XXIII

RANGE IN ANNUAL EQUIPMENT COSTS PER HUNDREDWEIGHT BY CLASSES OF WAREHOUSES

Annual equipment cost per cwt.	No. in group			
	Line	Co-operative	Independent	All
Cents				
Under 1.0	6	4	4	14
1.0 to 1.5	8	11	3	22
1.5 to 2.0	7	1	2	10
2.0 to 3.0	8	5	2	15
3.0 to 4.0	2	3	0	5
4.0 to 5.0	1	1	1	3
5.0 and over	1	1	0	2
All	33	36	12	71

The average cost per hundredweight for all warehouses, according to Table XXIV, is 1.6 cents. In spite of high costs per warehouse, the independents have much lower costs per hundredweight. This means that, as a whole, the extra volume of business warranted their more complete equipment on the score of costs alone, to say nothing about possible saving in labor costs and greater convenience of the patrons. There were individual warehouses, however, as the two handling between 10,000 and 15,000 hundredweight, for which this was not the case. The line houses handled so small a volume of business that even their low equipment costs per warehouse left them with the highest hundredweight costs of any group. It is altogether possible that in some cases more complete and more convenient equipment might have increased their volume enough actually to reduce their per hundredweight costs.

TABLE XXIV

EQUIPMENT COSTS PER HUNDREDWEIGHT BY CLASSES OF WAREHOUSES

Hundredweights (000's omitted)	Line		Co-operative		Independent		All	
	No.	Average	No.	Average	No.	Average	No.	Average
		Cents		Cents		Cents		Cents
Up to 10	14	2.40	5	2.70	2	2.04	21	2.44
10 to 15	10	2.26	5	2.28	2	2.93	17	2.36
15 to 20	6	1.09	4	2.08	0	0.00	10	1.50
20 to 40	3	1.05	6	2.20	4	0.93	13	1.54
40 and over	0	0.00	6	1.13	4	1.32	10	1.18
All	33	1.77	26	1.65	12	1.34	71	1.60

Table XXIV shows that, taking the 71 warehouses, costs per hundredweight decrease quite consistently with volume of business. Curve A in Figure 9 shows the same thing graphically and in more detail. The costs for the ten largest volumes are appreciably smaller

than for the next lower volume group of 13, but they are handling over 30,000 hundredweight more potatoes. The curve shows only slight decrease over 30,000 hundredweight, and especially over 50,000 hundredweight, and a very rapid decrease under 20,000 hundredweight. This indicates that there is a minimum of equipment which every warehouse must have, and costs decrease rapidly until this minimum is fully utilized; that from this point on to 30,000 hundredweight, the equipment is both increased and more fully utilized; and that above this point, equipment increases about as fast as volume of business, probably because certain major items have to be duplicated. Curve A may serve as a rough standard for purposes of comparison. If any warehouse finds its equipment costs are seriously out of line with this curve, it should determine the reasons for it and whether or not they are adequate.

Thus, as we examine individual warehouses, we find that No. 58, a line house, handling 11,000 hundredweight, has an equipment cost of 5.3 cents per hundredweight, nearly three times the average for this volume. Its building and other costs are somewhat high, but nothing in comparison with equipment costs. The volume of business is too small for a 36x70 ft. warehouse, but even if the volume of business were normal, equipment costs would be high. The equipment of the warehouse cost $2700 new, and the warehouse, $4450, a ratio of 60.8, as compared with 17.5 for the average. (See Table XXII.) This warehouse has a conveyor which cost $1500, and all other equipment in proportion.

Near the other extreme is No. 10, a co-operative house which handled 13,580 hundredweight at an equipment cost of 1.06 cents per hundredweight, about 0.7 cent under the average for this volume. The value of the equipment was only 8 per cent of the value of the building. The warehouse has no conveyors or elevators or dumping equipment. No doubt the warehouse could well afford to provide more convenient equipment.

No. 26, a co-operative warehouse, handled 230 cars at an equipment cost of 1.15 cents per hundredweight, which is perhaps a little high for this volume. The equipment cost 35 per cent as much as the warehouse, and is very complete.

No. 20, also a co-operative house, had as much equipment as No. 26 and handled only 32,000 hundredweight.

The lowest cost of all was for an independent house which handled 105 cars with $200 worth of old equipment. Needless to say, its labor costs were high. The highest cost for independents, 4.6 cents per hundredweight, was for a warehouse with $2800 worth of equipment handling only 40 cars. In this case, building costs were equally high.

Table XXV shows the distribution of equipment cost to five processes. Grading uses more equipment, on the average, than any other process. If all warehouses were equipped with conveyors and elevators and wagon dump scales, however, these percentages would be greatly changed.

TABLE XXV

DISTRIBUTION OF EQUIPMENT COSTS TO PROCESS

Process	Line		Co-operative		Independent		All warehouses	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Receiving	$ 26	12.4	$ 98	22.3	$135	32.7	$ 71	21.6
Grading	99	47.6	212	48.0	159	38.7	151	46.0
Sacking	5	2.4	14	3.1	12	2.8	9	2.8
Warehousing	39	18.6	67	15.2	54	13.0	52	15.7
Loading cars	40	19.0	50	11.4	53	12.8	46	13.9
Average	$209	100.0	$441	100.0	$412	100.0	$328	100.0

LABOR COST

Table I shows that labor is 24.7 per cent of all costs. Table XXVI shows the elements in labor cost. For the 71 warehouses the labor hired is 75.8 per cent of the total, and the labor performed by the manager is 23.6 per cent of the total. The division of the time of the manager between labor and office and management was a rough estimate. In general, time spent in buying and selling, correspondence, and keeping records was called office and management, and that devoted to the actual physical handling of the potatoes and the like was called labor. For the co-operative warehouses, labor was estimated as 45 per cent of the manager's time; for the independent houses, 27 per cent; and for the line houses, 53 per cent. As will appear later, a large part of the work of office and management for the line houses was performed in the central office. The local managers of such houses, therefore, had more time to devote to the actual labor of handling potatoes. Their smaller volume of business had the same effect.

TABLE XXVI

ELEMENTS OF LABOR COSTS FOR 71 WAREHOUSES

Elements of cost	Line		Co-operative		Independent		All warehouses	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Hired labor	$386	55.4	$1214	80.3	$1719	88.6	$913	75.8
Labor by manager	310	44.6	284	18.8	208	10.7	284	23.6
Liability insurance	*	*	14	.9	14	.7	7	.6
All	$696	100.0	$1512	100.0	$1940	100.0	$1205	100.0

* Employment liability included in home office overhead and prorated to office and management costs for each warehouse.

Twenty-seven of the 38 co-operative and independent warehouses carried liability insurance for employees amounting to $19.12 per warehouse, and about three fourths of this was charged to labor, the rest to office management. The line houses all carried liability insurance, but it has been included with office and management cost.

Labor costs may vary, either because the rates of pay are different or because of difference in the amount of labor used per hundredweight of potatoes handled. No analysis of labor costs which does not separate these two factors can be at all complete. The data needed for this are rates of pay by the day or hour, and days or hours worked. Such data were not obtained in the survey; in fact, can be obtained only as rough estimates by the survey method. In the analysis which follows, therefore, we shall consider directly variations in labor cost per hundredweight without taking up variations in rates of pay and hours per hundredweight.

If we could assume that rates of pay were the same for all warehouses, then labor cost per hundredweight would vary only because of differences in hours per hundredweight. The analysis which follows will roughly assume this. It will misrepresent the facts to the extent that rates of pay for hired labor vary in different warehouses, and to the extent that managers' salaries are different for various warehouses, and to the extent that each warehouse uses a different proportion of the manager's time at ordinary labor. A careful analysis of rates would, of course, show perhaps three different rates for the manager's time, a high rate for time spent in buying and selling, a somewhat lower rate for time spent on the records, and a still lower one for time spent at labor. But even this latter rate would be higher than the rates paid for hired labor.

LABOR COSTS PER HUNDREDWEIGHT

Table XXVII shows that the range in labor costs is from less than 4 cents to more than 11 cents per hundredweight. For all classes combined, over 50 per cent have labor costs between 5 and 7 cents per hundredweight, 18 per cent are under 5 cents, and 27 per cent are above 5 cents. Relatively more of the line and independent warehouses have costs over 7 cents per hundredweight, and relatively more of the co-operatives have costs under 5 cents per hundredweight. But the two highest labor costs are for co-operative warehouses. These high costs are very serious and must be reduced in most cases if the warehouse is going to succeed. Let us analyze the data to see the reason for the high costs and also for the low costs. It will not be possible, however, to single out all the reasons for the variations in labor costs. In the first place, not all the data needed are available; for example, as already explained, no data are available as to hours of labor and rates per hour: and there are many irregularities in the data obtained.

TABLE XXVII

RANGE IN LABOR COSTS PER HUNDREDWEIGHT, BY CLASSES OF WAREHOUSES

Labor costs per hundredweight	No. in group			
	Line	Co-operative	Independent	All
Cents				
Less than 4	3	1	1	5
4 to 5	1	6	1	8
5 to 6	10	5	3	18
6 to 7	9	9	3	21
7 to 8	7	1	2	10
8 to 9	3	1	0	4
9 to 10	0	1	2	3
10 to 11	0	1	0	1
11 to 12	0	1	0	1
All	33	26	12	71

Table XXVIII shows that difference in volume of business is one reason for difference in labor costs per hundredweight, but by no means the most important reason, as the labor cost for the 21 warehouses handling less than 10,000 hundredweight averaged only 2 cents more than for the group of 10 handling over 40,000 hundredweight, whereas the range in costs with any one volume group is anywhere from 4.2 to 6.2 cents. Table XXIX shows that for the 12 independent houses there is scarcely any decrease in cost with volume of business. By the same sign, volume is a somewhat more important factor in determining labor costs when line and co-operative warehouses are considered separately; but still not the main factor.

TABLE XXVIII

RELATION OF VOLUME OF BUSINESS TO LABOR COSTS PER HUNDREDWEIGHT IN 71 WAREHOUSES

Hundredweights (000's omitted)	No. in group	Labor cost per warehouse	Labor cost per cwt.		
			High	Low	Average
			Cents	Cents	Cents
Under 10	21	$ 534	11.43	5.21	7.40
10 to 15	17	714	9.56	4.61	5.95
15 to 20	10	1059	7.29	3.02	6.03
20 to 40	13	1551	9.58	3.56	5.85
40 and over	10	3137	9.42	3.75	5.44
All	71	$1205	11.43	3.02	5.89

TABLE XXIX

LABOR COST PER HUNDREDWEIGHT BY CLASSES OF WAREHOUSES

Hundredweights (000's omitted)	Line		Co-operative		Independent	
	No. in group	Av. for group	No. in group	Av. for group	No. in group	Av. for group
		Cents		Cents		Cents
Up to 10	14	7.22	5	8.19	2	6.52
10 to 15	10	6.06	5	5.78	2	5.88
15 to 20	6	5.67	4	6.52	..	...
20 to 40	3	3.98	6	6.01	4	6.74
40 and over	..	...	6	5.04	4	6.14
All	33	5.88	26	5.65	12	6.33

One of the principal reasons for the irregularities in labor costs is the attempt to divide the manager's time between labor and office management. Yet this separation was necessary in order to reduce labor costs of line houses and other warehouses to a comparable basis, as such a large part of office and management work for line houses is done in the central office. If the three types of warehouses are considered separately, however, the payroll can be considered as a unit. This method of analysis will, therefore, be followed for a while.

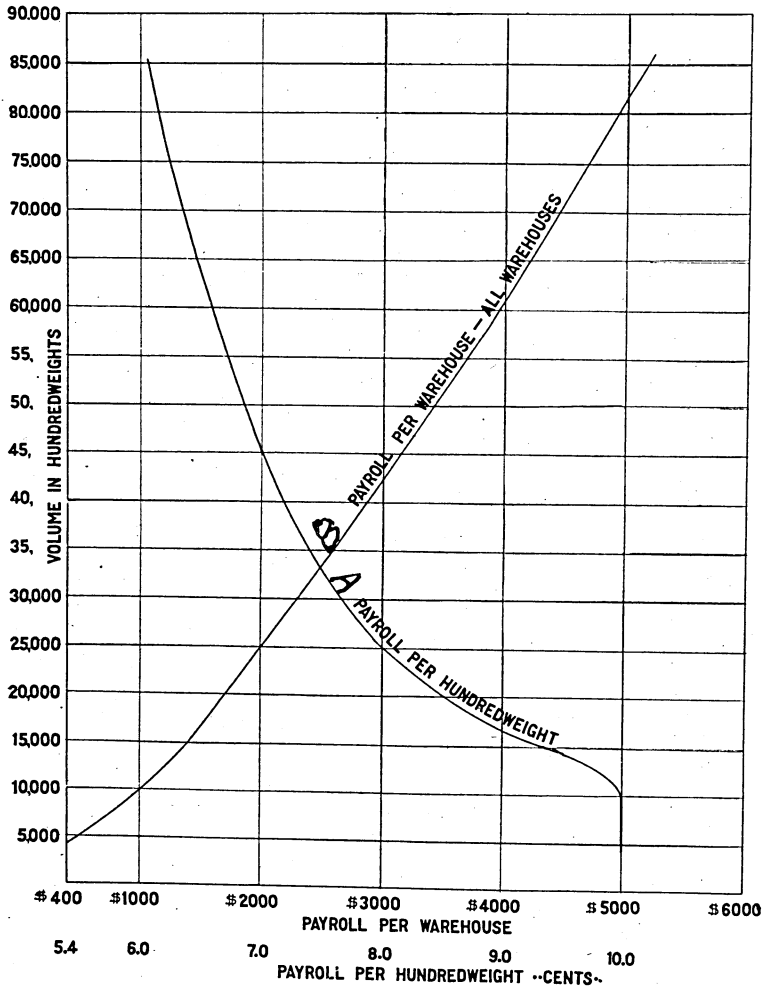

Fig. 10. Payroll per Warehouse, Increasing with Volume of Business; and Payroll per Hundredweight, Decreasing with Volume

Figure 10 shows graphically the relation between payroll and volume of business for all warehouses. Curve B is drawn freehand approximately through the midpoints of the groups arranged on the

basis of volume. It therefore expresses in rough average form the way in which payroll increases with output. Curve A shows the same relationship expressed in the form of payroll per hundredweight. If any warehouse has a payroll or payroll per hundredweight seriously out of line with the curve in Figure 10, there should be a reason for it, a sound reason which can be justified before the board of directors.

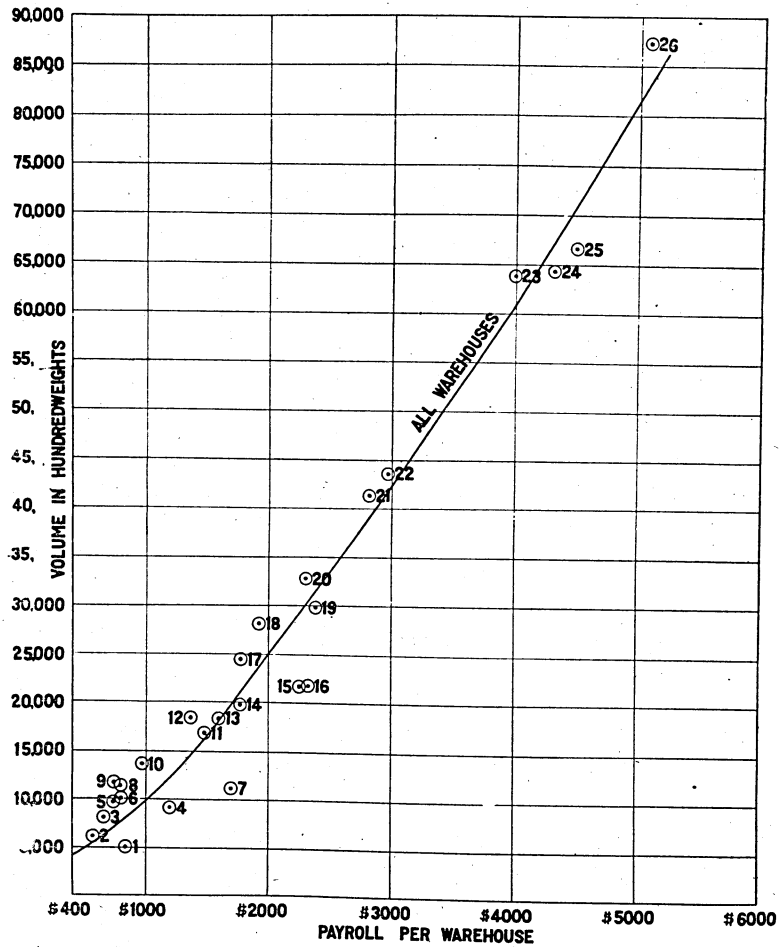

Fig. 11. Payrolls of Individual Co-operative Warehouses Compared with Average for All Warehouses of the Same Volume
(The curve represents the average for all warehouses.)

CO-OPERATIVE WAREHOUSES

Let us examine some of the warehouses that are seriously out of line, co-operative warehouses first. Table XXX shows the increase in payroll with volume of business and the effect of this on payroll per hundredweight. The range in payroll costs per hundredweight is from

6.5 cents for those handling over 40,000 hundredweight to 11.5 cents for those handling under 10,000 hundredweight. This is a range of 64 per cent of the average, which is to be compared with 56 per cent of the average for labor costs considered separately. (See Table XXIX.) The range within volume groups is correspondingly a little narrower, especially for the larger volumes. Figure 11 reproduces Curve B from Figure 10 and locates against the curve the 26 co-operative warehouses. It will be apparent that in general the payrolls of co-operative warehouses do not vary greatly from the average. The small co-operative warehouses, however, those with volume under 12,000 hundredweight, have lower payrolls than the average. Table XXX shows that this is because they pay their managers very low salaries. Table XXXI shows that the line houses in the volume group under 10,000 hundredweight paid their managers an average of $527, or $155 more than the co-operatives, and in the volume group from 10,000 to 15,000 hundredweight, $715, or $111 more than the co-operatives. The line houses probably realize better than the co-operatives the importance of a skillful manager even for a small business. The small line houses also stored a few more potatoes than the small co-operatives.

TABLE XXX

RELATION OF PAYROLL TO VOLUME OF BUSINESS OF CO-OPERATIVE WAREHOUSES

Hundredweights (000's omitted)	No. in group	Per warehouse			Per hundredweight		
		Managers' salaries	Other payroll	Total	High	Low	Average
					Cents	Cents	Cents
Under 10	5	$372	$506	$878	19.4	8.5	11.5
10 to 15	5	604	447	1051	15.7	6.5	9.1
15 to 20	4	911	902	1813	13.1	8.7	9.8
20 to 40	6	891	1337	2228	11.4	6.8	8.4
Over 40	6	1068	2881	3949	6.9	6.3	6.5
All	26	$780	$1295	$2075	19.4	6.3	7.8

TABLE XXXI

RELATION OF PAYROLL TO VOLUME OF BUSINESS OF 33 LINE HOUSES

Hundredweights (000's omitted)	No. in group	Per warehouse			Per hundredweight		
		Managers' salaries	Other payroll	Total	High	Low	Average
					Cents	Cents	Cents
Under 10	14	$527	$117	$644	13.6	7.8	10.1
10 to 15	10	715	495	1210	12.1	6.9	10.3
15 to 20	6	1025	589	1614	11.0	6.8	9.5
20 to 40	3	1110	484	1694	7.3	6.7	6.9
Over 40	..	....	....	....	...	..	..
All	33	$729	$688	$1417	13.6	6.7	9.4

The co-operative warehouses whose payroll is a little high are Nos. 1, 4, 7, 15, and 16. For No. 1, this is solely because the manager's salary is a little high for the volume of business handled. The apparent reason for this is that less business was handled than was expected. Miscalculation of this is unavoidable. In No. 4, considerable storing was done, and the manager was hired for a longer period than ordinarily. For No. 7 it seems to be due to high labor costs, apparently partly to inadequate equipment. For No. 15 it is due to very high manager's salary, and for No. 16 to very high labor costs. However, the plant seems to be well equipped, hence we must conclude that more labor was hired than needed, or that high wages were paid, or that the potatoes were very carefully sorted and graded, which may or may not have justified the extra cost.

LINE HOUSES

Figure 12 shows the location of payroll of the 33 line houses as compared with the average for the same volume. It will be noted that the payroll is higher than the average for the smaller volumes of business, and somewhat smaller than the average for volumes of business between 15,000 and 20,000 hundredweight. Table XXXI gives the data for this. Apparently the salary of the manager is responsible for most of the higher payrolls. In every volume group, but especially in the smaller ones, managers' salaries are higher than for co-operative warehouses. On the other hand, other payroll costs are lower—for the 14 co-operative warehouses handling less than 20,000 hundredweight, they average $598; for the 30 line houses of the same volume group, $371. As already pointed out, the managers of the line houses themselves do more of the work of handling the potatoes. Apparently 10,000 hundredweight or less can be handled by a manager of a line house with little or no extra labor; and above 10,000 hundredweight, about as much extra labor is needed for 12,000 as for 20,000 hundredweight. Utilization of labor is, therefore, partly a matter of adjustment of labor to volume of business. The co-operatives are apparently more likely to over-estimate volume of business than the line houses.

The line house payrolls most out of line are Nos. 58, 66, 67, 68, and 69. No. 58 operated on a combined commission and salary basis and had a low cost for other labor. Apparently the manager worked hard. The salaries of Nos. 68 and 69 were both low for the amount of business handled. The line houses show a slight tendency not to proportion salaries to larger volumes of business. No. 66, however, is a case to the contrary. The payroll of No. 67 is due to high extra labor costs. This warehouse handled 18,000 hundredweight practically without equipment.

The range in payroll cost per hundredweight for line warehouses is less than for co-operatives because the range in volume is less. For the same range in volume, it is greater if the group of three largest volumes is included, but otherwise less. The range between high and low costs is also less for the line houses. This is in keeping with the common observation that line companies tend to standardize their costs more than do independents and co-operatives.

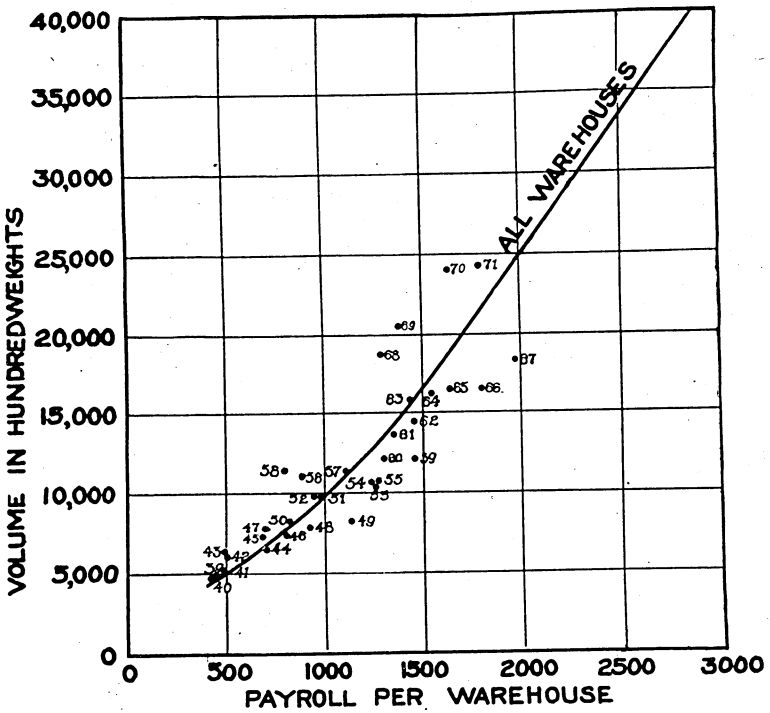

Fig. 12. Payroll of Line Houses Compared with Payrolls of All Warehouses of the Same Volume

The average payroll costs per hundredweight are 1.6 cents higher for line than for co-operative houses. For those under 20,000 hundredweight, however, the line house payroll costs are 9.7 cents per hundredweight, and the co-operatives' 10.2 cents per hundredweight. If the group 20,000 to 40,000 is included, the line houses will appear still more to advantage.

It should be pointed out here, however, that the manager of a co-operative house has more responsibility than the manager of a line house, and handles a larger proportion of the actual selling of the potatoes.

INDEPENDENT WAREHOUSES

There are not enough independent warehouses to give a good distribution, but it is obvious from Figure 13 that any sample taken would show more variations than for the other classes. The principal reason for this is that the operators of independent warehouses were erratic in estimating salaries for themselves. Apparently they did not standardize their salaries high on the whole. Nos. 27, 28, 33, 35, and 38 were especially low in their estimates.

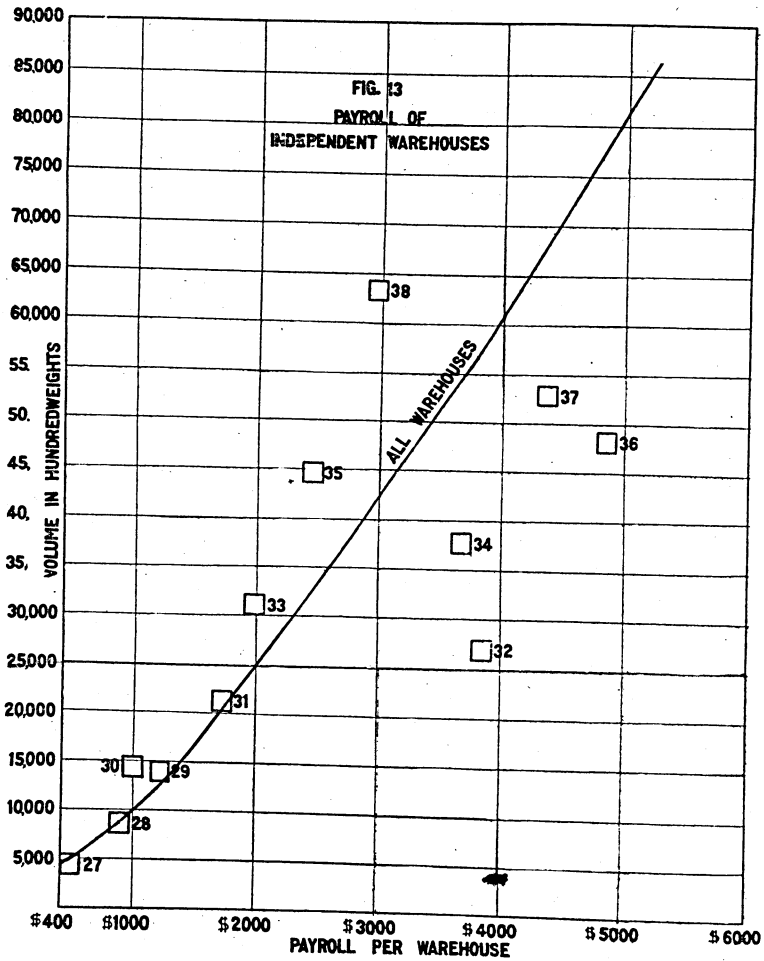

Fig. 13. Payrolls of Independent Warehouses Compared with Payrolls of All Warehouses with the Same Volume

Table XXXII shows that other payroll costs average $452 for the 4 handling less than 15,000 hundredweight, as compared with $476 for 10 co-operative and $274 for 24 line houses of the same volume groups.

The four large independent houses handled an average of 52,357 hundredweight (see Table X) with payrolls averaging $3220; the 6 large co-operatives handled an average of 61167 hundredweight with a payroll cost of $2881. The comparison for the 20,000 to 40,000 hundredweight group is about equally favorable to the co-operatives. Hence, in spite of a considerably larger average volume of business the independents show higher total payroll costs per hundredweight than the co-operatives. The 4 small independent houses show low costs, but the operators estimated their salaries at an average of only $312.

TABLE XXXII

RELATION OF PAYROLL TO VOLUME OF BUSINESS, INDEPENDENT WAREHOUSES

Hundredweights (000's omitted)	No. in group	Per warehouse			Per hundredweight		
		Managers' salaries	Other payroll	Total	High	Low	Average
					Cents	Cents	Cents
Under 10	2	$220	$361	$581	9.6	8.4	8.8
10 to 15	2	605	542	1,147	9.0	7.2	8.1
15 to 20	..	....	....	....	....	..	..
20 to 40	4	1060	1800	2,860	14.5	6.5	9.8
Over 40	4	825	3220	11,445	10.2	4.9	7.7
All	12	$766	$1657	$2,423	14.5	4.9	8.5

The costs for No. 32 are high because of a high estimated salary, and of Nos. 37 and 38 because of high payroll costs. To illustrate the difference in this respect, No. 38 handled 176 cars with payroll costs of $1882; No. 34, 105 cars at $2397; No. 37, 142 cars at $3416; and No. 36, 134 cars at $4392. This is a range from 3.3 cents to 9.4 cents a hundredweight.

TWO DIMENSIONS OF PAYROLL

It will be apparent from the foregoing discussion that a payroll may be high for a given volume either because too much labor is employed or because wages and salaries are high. It is not possible, with the data obtained in the survey, to show which of these is the more important cause in each case. In general, however, variations in amounts of labor used is the more important of the two causes. This means that warehouse managers need to look to the amount of labor employed as a source of high labor costs in many cases. Better and more complete equipment would help in many cases; in others, a better estimate in advance as to the amount of business to be handled.

DISTRIBUTION OF LABOR COSTS

Labor was distributed to the five processes on the basis of the manager's estimates of the actual division of time of the different employees between different operations. The data in Table XXXIII

therefore indicate the distribution only in a general way. Warehousing and sacking seem to be the most time-consuming operations, and constitute nearly two thirds of the total. The operations of receiving the potatoes and loading them into cars represent less than one fifth of the total. Different warehouses vary greatly in the proportion of labor used for different operations, depending upon equipment, arrangement of warehouse, amount of storing, and the like.

TABLE XXXIII

DISTRIBUTION OF LABOR TO PROCESSES

Operation	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Receiving	$ 38	5.4	$124	8.2	$120	6.2	$ 83	6.9
Grading	126	18.1	301	19.9	340	17.5	227	18.8
Sacking	186	26.7	410	27.1	545	28.1	329	27.3
Warehousing	271	39.0	496	32.8	702	36.2	427	35.4
Loading cars	75	10.8	181	12.0	233	12.0	140	11.6
Total av.	$696	100.0	$1512	100.0	$1940	100.0	$1205	100.0

OFFICE AND MANAGEMENT COST

Table I shows that office and management cost represents 26.7 per cent of all costs. It is thus a more important cost classification than labor. Of the $1554 charged to office and management for line houses, $996, or 64 per cent, represents central office costs distributed to the local line houses. The records of the central office charged the more direct expenses to particular local warehouses, but did not distribute salaries and similar items. These were prorated between locals arbitrarily on the basis of hundredweights of potatoes handled. This was not an entirely satisfactory basis of allocation, as some of the services performed in the central office did not vary with volume and, therefore, might better be allocated on a per warehouse basis. The correct procedure in such a case is to classify the time of the central office employees according to the basis on which it should be allocated, and to handle each classification in its proper way; but this ordinarily requires more detail than is possible with survey methods. The effect of using this method was, of course, to reduce the range of variations in office and management for line houses, especially the variations with volume.

None of the data for office and management cost, however, are very accurate. One reason for this is the one already pointed out, namely, that the payroll had to be divided more or less arbitrarily between labor, and office and management.

Table XXXIV shows the elements in office and management cost. Management cost includes the cost of that part of the time of the

manager which is devoted to buying and selling and directing the work of the other employees. Office cost includes the cost of that part of the time of the manager which is devoted to records and correspondence; also the salaries of the office helpers of all kinds, and such expenses as stationery and office supplies, telephone and telegraph, and the like. Table XXXV shows the division of office and management costs of line houses between the central office and the local units. The largest item of expense is salaries of managers, officers, and office employees, amounting to 59 per cent of the total. For the line houses, the salaries assigned to the central office, $454, represent 29 per cent of the total; the salaries of the local management, $409, represent 26.3 per cent; and the salaries of the office help, $128, all in the central office, represent 8.2 per cent. The total of these is $863, or 55.5 per cent.

TABLE XXXIV

ELEMENTS IN OFFICE AND MANAGEMENT COSTS BY CLASSES OF WAREHOUSES

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Officers' salaries	$ 60	3.9	$ 47	4.9	$ 84	6.3	$ 59	4.5
Managers' salaries	675	43.4	492	50.9	587	44.0	593	45.6
Office salaries	128	8.2	67	6.9	65	4.9	95	7.3
Office supplies	28	1.8	48	5.0	56	4.2	40	3.1
Telephone and telegraph	133	8.6	61	6.3	201	15.1	118	9.1
Market service	40	2.6	12	1.2	15	1.1	25	1.9
Interest	118	7.6	138	14.3	191	14.3	138	10.0
Miscellaneous	372	23.9	101	10.5	135	10.1	233	17.9
Total	$1554	100.0	$966	100.0	$1333	100.0	$1301	100.0

TABLE XXXV

DIVISION OF OFFICE AND MANAGEMENT COSTS PER WAREHOUSE BETWEEN CENTRAL OFFICE AND LOCAL WAREHOUSE FOR 33 LINE HOUSES

	Central office		Local warehouse	
	Amount	Per cent of total	Amount	Per cent of total
Officers' salaries	$ 60	5.4		
Managers' salaries	266	23.9	$409	93.0
Office salaries	128	11.5		
Office supplies	28	2.5		
Telephone and telegraph	122	10.9	11	2.5
Market service	40	3.6		
Interest	118	10.6		
Miscellaneous	352	31.6	20	4.5
Total	$1114	100.0	$440	100.0

The next largest item is interest. This represents interest actually paid on funds required to carry on the current business of the warehouse, plus interest at a similar rate on any funds belonging to the business and used in the same way. It is interest on what may be called

the "quick assets" of the business. These funds are tied up during the operating season in potatoes, sacks, labor, and other current inventories. For the co-operative houses, most of this quick capital was borrowed; for the line houses, more of it was owned than borrowed.

Office salaries represent salaries of bookkeepers or secretaries paid by 7 co-operative warehouses and by one independent warehouse, averaging $314 per warehouse for the 8. If one very high salary is omitted, the average for the other 7 is only $240. For all other co-operatives and independents the records and accounts were kept by the managers. The effect of employing special help for this in the case of the 8 warehouses was simply to release more of the manager's time for labor at handling potatoes.

A comparison of office and management expenses for the three classes of warehouses shows that they are much higher for line houses than for co-operatives and independents. The items mostly responsible for this are managers' salaries, office salaries, and miscellaneous. The salaries of the local managers of line houses are lower than those of the managers of co-operatives, but to these local salaries must be added $266 as the prorated share in the salaries of management in the central office. Office salaries in the local warehouses are the salaries of those who handle the records and accounts and correspondence in so far as it is not done by the managers themselves. In a line-house organization, as much as possible of this record keeping and correspondence is handled in the central office. The cost of record keeping and management is higher for the line houses for two reasons, one is that better records are kept, and the other that the central office of a line-house organization is a selling organization. As already explained, the co-operative houses sell only a small part of their potatoes themselves, whereas a line-house organization sells nearly all. It has not been possible in the survey to determine the central market selling expenses of individual co-operative and independent houses, but later in the bulletin, some rough averages will be given as to the amount of such costs which will make possible a general comparison with line-house selling expenses. At this point in the analysis, the reader must keep in mind that the office and management costs of the line-house organizations represent much more service than the office and management costs of most co-operative and independent warehouses.

This also accounts for the much higher miscellaneous costs of the line houses. Included in the miscellaneous costs of the central office are such items as automobile costs, traveling expenses, advertising and publicity, insurance, postage, exchange, depreciation on furniture and fixtures, office rent, and wages of yard men. A local co-operative or independent warehouse incurs some of this expense, but usually the

items are small, especially if the local is doing little of its own selling. as is usually the case. It will be noted that the miscellaneous expense of local line houses is only $20 as compared with $101 and $135 respectively for co-operative and independent warehouses. This indicates that the central office of a line-house organization takes over most of the functions which cause co-operative and independent warehouses to incur the various miscellaneous expenses.

The central office, it appears, takes over the whole burden of furnishing the quick capital of the business. Telephone and telegraph and market service costs of the line-house organizations are also appreciably higher than for the other classes of warehouses, which is what one would expect in view of the extra selling service performed.

It is rather significant that altho the absolute office and management payrolls per warehouse of line-house organizations are somewhat larger than for the other classes of warehouses—$863, as compared with $606 for co-operatives, and $736 for independents—the ratio of payroll costs to total office and management costs is relatively low (55.5 per cent) as compared with 62.5 per cent for co-operatives, and 55.2 per cent for independents. When these various costs are reduced to a hundredweight basis, however, the comparison takes on a quite different aspect.

OFFICE AND MANAGEMENT COST PER HUNDREDWEIGHT

Table XXXVII shows that the average office and management cost per hundredweight for the 71 warehouses was 6.4 cents, and that the range was from 1.3 to 17.9 cents. Table XXXVI shows that the office and management costs for co-operative and independent warehouses were nearly all under 8 cents per hundredweight, and for the line houses, all were over 8 cents per hundredweight. Table XXXVIII shows that the average for co-operatives was 3.6 cents; for independents, 4.3 cents, and for line houses, 13.1 cents. The smaller volume of business handled by the line houses makes this cost very high when reduced to a hundredweight basis. As already explained, this is in large measure due to the fact that the line-house organizations do their own selling, whereas the others hire it done. That this is not the whole explanation is indicated by the fact that the office and management payrolls of the local line houses alone were 3.5 cents per hundredweight, as compared with 2.6 cents for co-operative, and 2.1 cents for independent houses.

TABLE XXXVI

RANGE IN OFFICE AND MANAGEMENT COST, BY CLASSES OF WAREHOUSES

Cost per cwt.	No. in group			
	Line	Co-operative	Independent	All
Cents				
Under 2	0	3	2	5
2 to 4	0	8	3	11
4 to 6	0	10	2	12
6 to 8	0	4	3	7
8 to 10	4	1	2	7
10 to 12	7	0	0	7
12 to 14	11	0	0	11
14 to 16	7	0	0	7
16 to 18	4	0	0	4
All	33	26	12	71

TABLE XXXVII

RELATION OF VOLUME OF BUSINESS TO OFFICE AND MANAGEMENT COSTS PER HUNDREDWEIGHT FOR 71 WAREHOUSES

Hundredweight (000's omitted)	No. in group	Per warehouse	Per hundredweight		
			High	Low	Average
			Cents	Cents	Cents
Under 10	21	$710	15.9	2.7	9.8
10 to 15	17	1277	17.9	3.3	10.7
15 to 20	10	1761	16.0	2.2	10.0
20 to 40	13	1591	12.7	1.9	6.0
40 and over	10	1739	5.2	1.3	3.0
All	71	1300	17.9	1.3	6.4

TABLE XXXVIII

OFFICE AND MANAGEMENT COST PER HUNDREDWEIGHT BY CLASSES OF WAREHOUSES

Hundredweights (000's omitted)	Line		Co-operative		Independent	
	No. in group	Average for group	No. in group	Average for group	No. in group	Average for group
		Cents		Cents		Cents
Under 10	14	12.3	5	5.2	2	4.9
10 to 15	10	14.5	5	5.0	2	6.1
15 to 20	6	13.5	4	5.3	..	..
20 to 40	3	11.6	6	3.8	4	5.7
40 and over	..	....	6	2.8	4	3.3
All	33	13.1	26	3.6	12	4.3

The correlation of office and management cost with volume of business in Table XXXVII is misleading in view of the fact that a majority of the small warehouses are line houses which did their own selling, and most of the large houses are co-operatives and independents which did little or no selling. This same correlation, however, is indicated in Table XXXVIII by classes of warehouses. For the co-operatives, the office and management costs of the largest 6 warehouses handling an average of 61,166 hundredweight were 54 per cent of the same costs of

the smallest 5 handling an average of 7631 hundredweight. For the independents, the same costs for the 4 largest, handling an average of 52,357 hundredweight, were 67 per cent of the costs for the 2 smallest, handling an average of 6606 hundredweight. The analysis for the different warehouses of the line houses is of very little value, for the reason already given, that the central office costs, constituting 72 per cent of the total, were mostly prorated to the different warehouses as a flat rate per hundredweight. The small decrease in costs per hundredweight with volume that does appear, is mostly due to variation in local office and management costs, chief of which is the salary of the manager.

Figure 14 shows graphically the relation between volume of business and office and management costs per warehouse (Curve B) and per hundredweight (Curve A) for the co-operative and independent warehouses; and shows the location with respect to Curve B for each of the co-operative and independent warehouses. The distribution is rather irregular, and the number of cases is hardly adequate to furnish the basis for such a curve. A principle reason for the irregularities is, of course, the errors made in dividing payroll between labor and office and management. The diagram itself, however, furnishes a rough basis for testing the office and management cost of any local warehouse. Curve C represents a rough average by volume of the local costs of line warehouses. It is interesting to note that office and management costs increase more rapidly than volume of business for warehouses under around 10,000 hundredweight. Curve A in Figure 10, representing payroll, showed a slight tendency of the same sort. It now appears that this tendency was derived from the office and management part of the payroll. This is in keeping with general observation and experience with respect to management cost in small business units. The very smallest units in the fields of both merchandising and manufacturing, are managed with very little tangible outlay for management —what managing is needed can be carried on incidentally to the labor part of the business. A point in size is soon reached, however, at which considerable special time must be used for managing, and it is usually at a point not far beyond this that per unit management costs are highest. Above this point, unit management costs frequently decrease even more rapidly than unit labor costs. In this case, of course, the condition resulted because the managers of very small warehouses designated a very small part of their time as used especially in managing.

When individual records are examined in more detail, further reasons are noted for some of the wide variations that occur. No. 12, for example, employed a bookkeeper at a salary of $930, altho handling

only 18,000 hundredweight of potatoes. No. 15 paid its manager $1500, altho handling only 21,000 hundredweight. A small sideline business was made the excuse for hiring a full-time manager. Did it pay? At the other extreme is No. 25, which handled 67,000 hundredweight with a $350 manager, and interest and all other costs low in proportion; and No. 21, which handled 41,000 hundredweight with a $300 manager, only $50 interest, no market service, and a negligible telegraph expense.

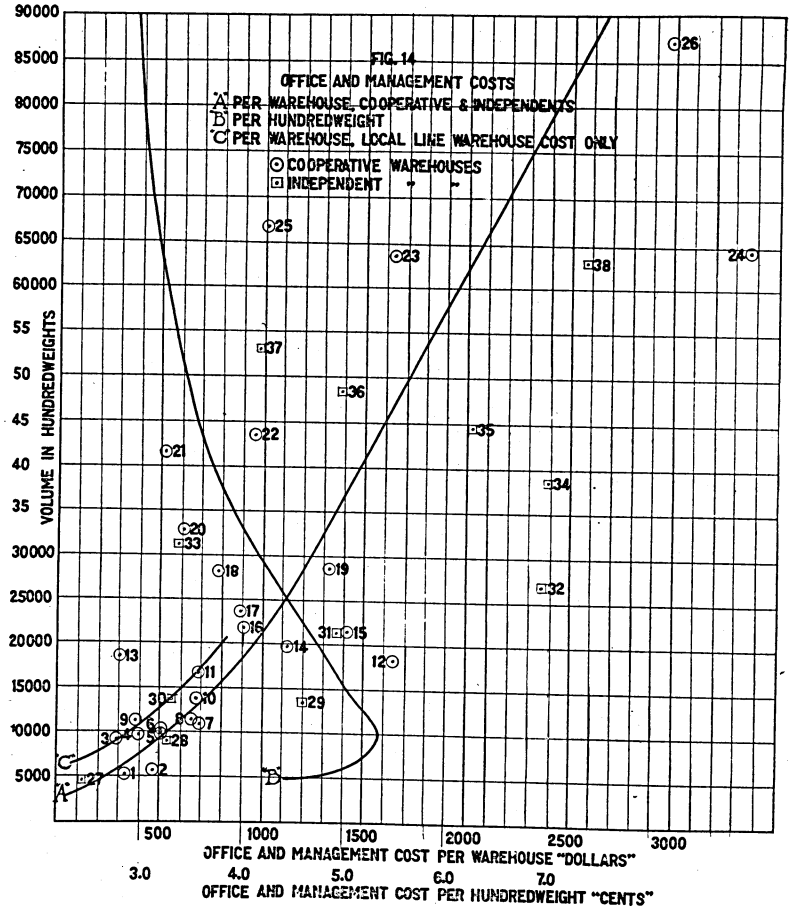

Fig. 14. Average Office and Management Costs of Warehouses, by Volume of Business

These are, of course, only costs—they do not indicate the amount and quality of the service that was rendered in return for the expenses incurred. For No. 26, for example, office and management costs were a little high. This warehouse sold practically all its crop direct to farm bureaus and dealers in the Corn Belt. No. 38, whose costs are also high, sold all but one car direct to retailers. But No. 22 had low costs

and yet sold its crop either on track, or direct to retailers. On the other hand, both No. 12 and No. 15, already mentioned, sold mostly through the Minnesota Potato Exchange. However, in spite of these irregularities, office and management costs show the effects of different methods of selling. After allowance was made for difference in volume of business, 16 of the 38 co-operative and independent warehouses, represented in Figure 13, which consigned all or most of their potatoes to commission firms, brokers, the Minnesota Potato Exchange, and the like, had average office and management costs 14 per cent under the average; 10 which sold mostly on track had average office and management costs 3 per cent above the average; and 6 which sold mostly direct to retailers, farm bureaus, and the like, had average office and management costs 33 per cent above the average. This means that for a co-operative or independent warehouse the office and management cost of selling an average volume of potatoes (20,449 hundredweight) direct would have been 5.3 cents per hundredweight; selling on track, 4.0 cents per hundredweight; and consigning, 3.3 cents per hundredweight. This represents a difference between the two extremes of 2 cents per hundredweight, or about $7 per car.

Differences in selling methods are one of the principal reasons for variations in several of the elements that make up office and management cost, especially telegraph and telephone, market service, manager's salary, and interest. Telegraph and telephone and market service cost the 38 independent and co-operative houses about 0.43 cent per hundredweight; and the 6 doing mostly direct selling, 0.53 cent per hundredweight, even tho they handled one half more business. Office and management salaries represent as high a rate per hundredweight for the 6 handling an average of 42,000 hundredweight, as for the 38 handling an average of 28,000 hundredweight; and the same is true of other office costs. The average interest cost on working capital was 0.56 cent for the 38, and 0.61 cent for the 6 doing direct selling. The warehouses handling a larger volume apparently secured a more rapid turnover for their working capital.

Interest costs, however, are more dependent upon buying methods than upon selling methods. For the line houses buying a small volume altogether for cash and doing a relatively large amount of storing, the average interest cost for working capital was 1.0 cent per hundredweight; for the independent houses, which bought a much larger volume mostly for cash, the average was 0.62 cent per hundredweight; for the 26 co-operatives handling a somewhat smaller volume and many of them pooling, 0.52 cent per hundredweight; and for 9 co-operative warehouses which pooled and sold mostly through the Minnesota Potato Exchange, only 0.15 cent per hundredweight.

There are, however, wide variations in interest and other costs due to other causes than buying and selling methods. One warehouse incurred interest costs of $850 on 161 cars, buying for cash and selling entirely on consignment; another, only $209 on 230 cars, buying for cash and selling direct. The former stored only 42 cars and the latter 52 cars. Interest is a cost that needs to be watched very closely. As already indicated, only 7 of the 38 warehouses paid special salaries for bookkeeping. Only 19 incurred any appreciable expenses for market and telegraph service, and the range in the amounts paid for such service was all the way from 50 cents a car (60 cars for $30), to $3 per car (15 cars for $45). One warehouse paid $435 for market and telephone service on 230 cars; another $210 for such service on 161 cars. Office supplies ranged from a few dollars to $159 for a warehouse handling only 51 cars. Included in miscellaneous costs are several items which varied greatly, for example, advertising and publicity, an expense incurred by only 11 of the 38, and ranging as high as $45 for a warehouse handling 28 cars.

An attempt was made to separate office and management cost between office and management. Office cost was defined to include everything except that portion of the manager's time which was devoted to buying and selling, supervision, and the like. Each manager was asked to estimate the division of his time between management and work on the records and accounts. Table XXXIX presents the results of this division. For all warehouses, the cost of management was 3.07 cents per hundredweight; of office, 3.13 per hundredweight, divided between 0.56 cent per hundredweight for time of the manager and 2.57 cents per hundredweight for other office costs. This calculation assumes the same rate for the manager at both types of work, which is not a proper assumption. The managers of co-operative houses spend relatively more of their time at office work than those of either line or independent warehouses. For both co-operatives and independents, the office is a larger cost than management. This is because it included, in addition to the items mentioned, the two large elements: interest, and market and telegraph service.

TABLE XXXIX

DIVISION OF OFFICE AND MANAGEMENT COST BETWEEN OFFICE AND MANAGEMENT

Class	Manager's salary				Other office		Per hundredweight	
	Management		Office					
	Per warehouse	Per cwt.	Per warehouse	Per cwt.	Per warehouse	Per cwt.	All management	All office
		Cents		Cents		Cents	Cents	Cents
Line	$273	2.30	$135	1.14	$620	4.15	6.45	6.40
Co-operative	349	1.30	141	0.53	404	0.27	1.57	2.04
Independent	463.	1.52	0	0.00	538	0.78	1.23	1.76
All	$333	1.62	$114	0.56	$526	2.57	3.07	3.13

Table XL attempts to show the distribution of office and management cost to processes. This table is to be interpreted more as indicating, in a general way, the authors' judgments as to how office and management cost is probably distributed than any definite results of statistical and accounting analyses. Some of the elements of office and management cost, it is true, could be definitely charged to buying, selling, and, in some cases, to warehousing; but for others this was not the case. In the latter class, especially were office and management salaries. The manager's office and management time was distributed first between buying, selling, and supervision, on the basis of his own estimates largely. Record keeping was considered as a part of buying and selling. The average distribution resulting was about as follows: buying, 25 per cent; selling, 35 per cent; supervision, 40 per cent. Next, supervision was distributed to receiving, grading, sacking, warehousing, and loading cars in proportion to the amount of labor used by each, it being assumed that supervision was more nearly proportional to labor than to space or equipment, or to all three combined. The assumption is, of course, not altogether sound—grading, for example, no doubt takes supervision out of proportion to labor—but it comes near enough to the truth for the purpose in hand. The errors resulting probably will not seriously affect the process-cost analysis, as office and management is so small a part of all of them except buying and selling, and makes up all of buying and selling.

TABLE XL

DISTRIBUTION OF OFFICE AND MANAGEMENT COSTS TO PROCESSES

Process	Line		Co-operative		Independent		All	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Buying	$544	35	$265	28	$403	30	$418	32
Receiving	11	1	19	2	16	1	14	1
Grading	34	2	58	6	48	4	46	4
Sacking	53	3	77	8	80	6	66	5
Warehousing	71	5	100	10	91	7	86	7
Loading cars	22	1	27	3	36	3	26	2
Selling	819	53	419	43	660	49	645	49
Total	$1554	100	$966	100	$1333	100	$1301	100

SALARIES OF MANAGERS

Table XLI shows the range in salaries of managers by classes of warehouses. Only five are over $1500, and all of these except one are for co-operative managers. The three highest salaries are $1700, $1800, and $2400. In three cases where considerable sidelines were handled, part of the salary was set aside for the sideline business. The salaries given are therefore for the potato business only.

In small warehouses, a large part of the manager's salary is merely wages of labor, and the same is true to some degree of the manager's salary in even the very large warehouses. The management is undoubtedly paid a higher rate than labor; and this should cause managers' salaries to tend to increase more rapidly than volume of business.

TABLE XLI

RANGE IN MANAGERS' SALARIES BY CLASSES OF WAREHOUSES

Annual salaries	No. in groups			
	Line	Co-operative	Independent	All
$ 100 to $ 300	3	3	1	7
300 to 600	7	6	4	17
600 to 900	14	5	4	23
900 to 1200	6	6	1	13
1200 to 1500	3	2	1	6
1500 and over	..	4	1	5
All	33	26	12	71

Table XLII shows that this effect is very evident with warehouses handling less than 15,000 hundredweight, and especially with those handling less than 10,000 hundredweight. Above this point, however, this effect is more than offset by the better utilization of management itself. This table can serve as a rough general guide to salaries for warehouses with various volumes. The salaries given are only averages of salaries actually paid. Probably all are a little high for the volume indicated because the potato crop was short the year of the survey. Salaries of line and co-operative house managers are about the same over 15,000 bushels. Under this point, line-house salaries are about 10 per cent under the average, and co-operative warehouse salaries about 10 per cent above the average. The reason for this is that the line-house managers do not have as many records to keep, and do not have as much responsibility.

TABLE XLII

VARIATION IN SALARIES OF MANAGERS WITH VOLUME OF BUSINESS

Volume	Salaries		
	Line	Co-operative	Both
5,000	$ 325	$ 375	$ 350
10,000	650	750	700
15,000	900	950	925
20,000	1050	1050	1050
25,000	1125	1125	1125
30,000	1200	1200	1200
40,000	1350	1350	1350
50,000	1500	1500	1500
60,000	1650	1650	1650
70,000	1800	1800	1800

OTHER DIRECT COSTS

Other direct costs include a miscellaneous group of items not properly included under the four principal elementary costs, because they vary for different reasons, or because they are not proratable to processes on the same basis.

Table XLIII lists these items and shows their relative importance for the three classes of warehouses. By far the largest item is sacks, tags, and twine, which is 92.7 per cent of all other direct costs, and 26.8 per cent of all warehouse costs.

TABLE XLIII

ELEMENTS IN OTHER DIRECT COSTS

Items of cost	Line		Co-operative		Independent		All	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Sacks, tags, and twine	$678	89.0	$1753	94.2	$2060	93.5	$1306	92.7
Fuel	40	5.2	63	3.4	87	3.7	56	4.0
Insurance on potatoes	13	1.7	19	1.0	6	0.3	14	1.0
Rent of scales	12	1.6	2	0.1	....	....	6	0.4
Car linings	7	0.9	20	1.1	44	2.0	18	1.3
Drayage on potatoes	3	0.4	....	....	10	0.5	3	0.2
Miscellaneous	9	1.2	3	0.2	....	....	5	0.4
Total	$762	100.0	$1860	100.0	$2204	100.0	$1408	100.0

The ordinary range in other direct costs is from 5.5 to 8.0 cents per hundredweight of potatoes handled. The extreme variations are probably due to errors in inventory and the like. The average for line houses is 6.4 cents per hundredweight; for co-operatives, 7.0 cents; for independent houses, 7.2 cents; and for all combined, 6.9 cents.

Sacks, tags, and twine costs should be proportional to volume, except for difference in purchase price due to buying at different times, or buying in larger quantities as practiced by some of the larger houses. The average for the larger houses was, however, not quite one cent per hundredweight less than for the smaller houses. The average for the line houses was 5.8 cents; for the co-operatives, 6.6 cents; for the independents, 6.7 cents; and for all combined, 6.4 cents.

The remainder of the other direct costs average only $102 per warehouse, being slightly higher for the line houses than the others, principally because of higher fuel and insurance costs.

Most of the cars are already lined when they reach the warehouses, the managers preferring to ship on this basis. Even when they are lined by the local warehouses, the linings may be returned and used again several times. The car linings cost given is for 37 warehouses which did more or less car lining on this basis, most of them only a little.

Drayage cost is for hauling potatoes by only three warehouses, and amounted to $70 per warehouse for these three.

Rent of scales is for seven warehouses which paid for having their potatoes weighed on public scales, or rented scales for the season. The average cost for the seven warehouses was 0.5 cent per hundredweight.

Insurance on potatoes was paid by twenty-five warehouses, mostly line houses doing considerable storing, and amounted to 0.5 cent per hundredweight of potatoes stored.

Miscellaneous costs consisted of an assortment of unusual items, chief of which were traveling expenses, collection of claims, miscellaneous freight and express.

These other direct costs were distributed as follows:

Sacks, tags, twine, and drayage were not distributed.

Fuel was distributed on the same basis as building and site.

Insurance on potatoes was charged to storage.

Rent of scales was charged to receiving.

Car linings was charged to loading car.

Drayage on potatoes and miscellaneous were combined and carried as a miscellaneous item in the final distribution to processes.

PROCESS COSTS

In this section of the bulletin, the elementary costs will be distributed so far as possible or feasible to the several processes named in Table I, in order to furnish a method for closer analysis of the reasons for variations. Equipment cost, for example, has to be studied by individual items of equipment before much can be done in the way of reducing it. The warehouse which gets the fullest use of its graders, dump scales, and conveyors will have the lowest equipment costs, prices of equipment being the same. The same is true of labor and building space.

The data obtained in the survey, however, were not sufficiently complete to make such a detailed analysis possible in most cases. Therefore only a few tables of data will be included, and the rest will be merely suggestive. The data given must be understood as indicating only very roughly the relative importance of the various cost elements in each process and the reasons for variations.

BUYING COSTS

The only cost element charged to buying is office and management. According to Table XL, buying represents 32 per cent of all office and management cost, as compared with 49 per cent for selling. The office part of office and management cost, as separated in Table XXXIX, was almost all distributed to buying and selling, and in addition about

60 per cent of the manager's time. One important exception was interest cost, which in the case of warehouses buying for cash and storing was charged largely to warehousing.

Buying costs, according to Table I, are 8.6 per cent of all warehouse costs for all warehouses combined, but only 4.7 per cent for co-operative houses, and 6.1 per cent for independent houses. Table XL indicates 35 per cent of all office and management cost of line houses charged to buying as compared with 28 per cent for co-operatives. On a hundredweight basis, buying costs are 4.6 cents for line houses; 1 cent for co-operatives; and 1.3 cents for independents. Buying costs for line houses are high because all office and management costs of line houses are high, and also because buying is supervised closely by the main office.

Buying costs of co-operative and independent warehouses range mostly between 0.5 cent and 2 cents per hundredweight, the variations depending upon the salary rate for office and management cost, and the proportion of this cost charged to buying. As the latter is based entirely on estimates, the results are not worth careful analysis. No doubt, however, some warehouses are giving proportionally much more time to buying than are others. It is a very important part of the business of operating a warehouse, no matter what the methods may be, whether buying for cash, pooling, or buying on commission for a dealer. It is here that the contact with the grower is largely obtained, and it is through the contacts obtained at this time that the manager secures the support of his patrons or members, and enlists their co-operation in such important measures as standardizing varieties, keeping varieties pure, treating seed for disease, better harvesting methods, and field sorting. Pricing and buying a load of potatoes from a grower should be a painstaking operation, calling for knowledge of grades and prices, and the exercise of much diplomacy and tact. Any really satisfactory pooling system which gives due consideration to differences in quality will require the same care and pains.

The potato warehouse which really serves its community satisfactorily, in the future must be one which engages actively in improvement programs. One of the important problems of the future is to determine how work of this kind is to be carried on, whether by a manager employed during the growing, as well as the harvesting and marketing, season, or by a special agent operating on a county or some other basis.

RECEIVING COSTS

Receiving costs are 5.2 per cent of the costs of co-operative warehouses; 4.4 per cent of the costs of independent warehouses; and 2.5 per cent of the costs of line warehouses. On a hundredweight basis,

the comparison is as follows: co-operatives, 1.09 cents; independents, 0.94 cent; line houses, 0.77 cent. Table LXIV, giving the elements of receiving cost, shows that line houses have low receiving costs in general because they have little building space set aside for receiving. It was pointed out earlier in the bulletin that many line houses sacrifice the convenience of their patrons for the sake of keeping operating costs down, and it is in the receiving department that this is particularly in evidence. Even receiving labor is greatly reduced. This means that the growers do most of the work of unloading.

TABLE LXIV

ELEMENTS OF RECEIVING COST

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Building	$ 4	4.9	$ 46	16.0	$ 17	5.9	$ 22	11.1
Labor	38	41.6	124	42.8	120	41.8	83	42.4
Equipment	26	28.6	98	33.9	135	46.8	71	35.9
Office and management	11	11.9	19	6.6	16	5.5	14	7.3
Other direct costs*	12	13.0	2	0.7	....	....	6	3.3
Total	$ 91	100.0	$289	100.0	$288	100.0	$196	100.0

* Scales rented by 7 warehouses.

The receiving process begins when the potatoes arrive at the warehouse, and ends when the potatoes are ready to be elevated to the graders. The only equipment usually involved is the wagon scale, either with or without a dump, and the power equipment to operate the dump. As already explained, many warehouses have their potatoes weighed at public scales and 7 paid for this weighing. The receiving equipment, if housed at all, is housed in a lean-to, usually of light construction. Only about one fourth of the warehouses had any building cost charged to receiving, and most of these were co-operative warehouses.

The range in receiving costs in co-operative and line warehouses is mostly from 0.7 cent to 2 cents per hundredweight, only 9 falling under this group, and only 4 going above it. For line houses, the range is mostly from 0.3 cent to 1.2 cents per hundredweight. The reasons for these variations appear when individual warehouse receiving costs are examined.

First of all, equipment costs vary greatly. Of the 71 warehouses, only 31 had dumping equipment. The receiving equipment costs of these 31 were 0.55 cent per hundredweight, as compared with 0.20 cent per hundredweight for the remaining 40 warehouses. Building costs charged to receiving for the 31 warehouses were 0.14 cent per hundredweight, as compared with 0.10 cent per hundredweight for the

others. Labor costs charged to receiving were practically the same for the two groups. Dumping equipment saves warehouse labor, but still more the labor of the growers, who usually unload their own potatoes if dumps are not provided. Receiving costs of the warehouses without dumps average 0.77 cent per hundredweight; of those having dumps, 1.13 cents per hundredweight. But those without dumps are smaller. When the effect of this difference in volume was allowed for, it cost on the average about 13 cents more per wagon load, or 78 cents more per carload, to provide dumping equipment. Against this 11 cents must be set the extra time of the grower and his team both while actually unloading and while waiting in line to unload. In the rush of the potato harvesting season, this can easily amount to much more than 13 cents.

The argument against using dumps is frequently advanced that it results in more bruised potatoes. Modern equipment, however, is little open to this objection.

One of the most important determinants as to whether or not to install dumping equipment is volume of business. Table XLV shows that receiving costs per hundredweight of warehouses with dumping equipment decrease rapidly for warehouses handling under 20,000 hundredweight, but very little from here upward, the reason being that beyond this point equipment and space are duplicated. For warehouses without dumping equipment, receiving costs per hundredweight actually increase at the beginning, probably because additional labor is not so well utilized. At 10,000 hundredweight, dumping equipment costs 0.85 cent more per hundredweight; at 20,000 hundredweight, 0.42 cent; at 30,000 hundredweight, 0.33 cent.

TABLE XLV

RELATION OF RECEIVING COSTS PER HUNDREDWEIGHT TO VOLUME OF BUSINESS

Volume	With dumps	Without dumps
Cwt.	Cents	Cents
5,000	2.25	0.60
10,000	1.60	0.75
20,000	1.22	0.80
30,000	1.13	0.80
40,000	1.12	...
50,000	1.11	...
60,000	1.10	...
70,000	1.10	...

Individual warehouses, however, vary greatly from the averages in Table XLV. No. 15, handling 21,600 hundredweight, had receiving costs of 0.0186 per cent, owing to high equipment inventory; No. 18 handled 30,000 hundredweight with less than half as high an investment in receiving equipment.

GRADING COSTS

Table I shows that grading represents 10.9 per cent of all costs. The grading process begins with the elevating of the potatoes to the grader, and ends when the potatoes leave the grader to enter the sacks, or a conveyor, or a hopper. The equipment involved is the grader, sometimes with a special picking table, and the gas engine or motor to operate it. Graders range considerably in capacity, and the larger warehouses may have two or three graders. The labor is that of picking over the potatoes and of looking after the graders, which need considerable attention, owing to clogging and the like. Sometimes during the rush season, as many as four or five men are employed at this work. But at slack seasons, only one man may be employed, the potatoes being fed to the grader more slowly, or culled less carefully. The space requirements include the space actually occupied by the graders, and the work space around them.

Table XLVI shows that labor and equipment make up three fourths of all grading costs. The decrease in grading costs with volume of business will therefore depend principally upon these two elements. The decrease in equipment costs with volume is very rapid up to 20,000 hundredweight, to the point where a small-sized grader is fully utilized, and rather slow from here upward, either because larger graders are used, or because equipment is duplicated. The labor curve for grading cost follows the same general direction as for labor in general in Figure 10 and Table XXVIII; that is, it decreases rapidly up to 15,000 hundredweight, and less rapidly from there upward. But the decrease is less rapid at the beginning than for equipment, and somewhat faster above the middle. The special curve for labor used in grading is bent somewhat less than the general labor curve, as the extra labor hired for culling potatoes can frequently be pretty well adjusted to the needs from week to week.

TABLE XLVI

ELEMENTS OF GRADING COST

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Building	$ 79	23.3	$139	19.7	$120	18.0	$108	20.4
Labor	126	37.2	301	42.3	340	50.9	226	42.7
Equipment	99	29.4	212	29.8	159	23.9	151	28.4
Office and management	34	10.1	58	8.2	48	7.2	45	8.5
Total	$338	100.0	$710	100.0	$667	100.0	$530	100.0

There is a wide range in grading costs for individual warehouses of about the same volume. These are accounted for mostly on the score of more or less grading capacity than is needed, or varying

amounts of labor or wage rates for labor. The misfits in grading capacity and volume were partly due to wrong forecasts of volume of business, and partly to carelessness in adjusting grading capacity to the volume expected. Part of these misfits can surely be prevented. The variations in labor costs are partly due to different degrees of care in sorting the potatoes, and partly to carelessness in hiring the right amount and kind of labor. It is of course possible to spend more upon careful sorting than is worth while; but probably this does not very often happen. The more carefully growers can be induced to sort in the field, the less the labor cost of sorting at the warehouse. It is always a question, however, as to where it is cheaper to do it.

Some typical cases of high and low grading costs are the following: Nos. 8, 9, and 10 each handled about 11,000 hundredweight, one with one grader, one with two, and one with three, with motor equipment in proportion. Labor and building costs were about the same, and yet the range in grading costs was from 0.27 cent to 0.54 cent per hundredweight. No. 35 handled 45,000 hundredweight with two graders and half the labor expense of No. 36, handling 48,000 with three graders. The largest warehouse covered in the survey handled 83,000 hundredweight with three graders and $650 labor cost, which is one third under the average.

The average grading cost per hundredweight is 0.26 cent. The average for line houses is only 0.29 cent, in spite of their small volume of business. This is because they seem to have better utilization of labor and equipment than the co-operative and independent warehouses. The costs of grading were especially high for the co-operative warehouses. The ordinary range in grading costs per hundredweight was from 0.15 to 0.45 cent.

SACKING COSTS

The sacking process begins when the empty sacks are placed on the sack-holder and ends when the sacks have been filled, weighed, and sewed, ready to be conveyed to temporary or permanent storage. The only equipment used is the sack-holder and platform scales; but considerable work space may be needed for the filled sacks while they are waiting to be carried away. Labor is, of course, the major item of cost. Sacking cost will therefore vary with volume handled much as total labor cost varies. Other variations are due to differences in wage rates and adjustment of labor employed to labor needs. The average for all warehouses is 0.244 cent per hundredweight, nearly the same as for grading cost.

TABLE XLVII

ELEMENTS OF SACKING COST

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Building	$ 65	21.1	$127	20.3	$118	15.6	$ 97	19.3
Labor	186	60.2	410	65.2	545	72.3	329	65.6
Equipment	5	1.6	14	2.2	12	1.5	9	1.9
Office and management	53	17.1	77	12.3	80	10.6	66	13.2
Total	$309	100.0	$628	100.0	$755	100.0	$501	100.0

WAREHOUSING COSTS

Table I shows that warehousing represents 21.5 per cent of all warehouse costs. Warehousing represents a miscellaneous group of activities, including conveying potatoes to storage, running conveyors, re-sorting, carrying out culls, clearing out bins, running the stove, and looking after the warehouse during the storage period. It becomes, in a sense, the residual claimant for all the labor not charged to other processes. The labor charged to it is therefore probably higher than it should be. Some of the labor so used, however, has few alternative uses at the time, and would be rated low under an accurate system of cost accounting. The labor charged to warehousing is 35 per cent of the total. The most important element in warehouse cost is of course building and site. The $468 of building cost charged to warehousing in Table XLVIII is 73 per cent of the total building and site cost. The principal item of equipment involved in warehousing is the conveyor. But only 16 warehouses had conveyors. The equipment charge for the others is for trucks, stoves, and the like.

TABLE XLVIII

ELEMENTS OF WAREHOUSING COST

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Building	$317	44.5	$618	47.6	$557	39.5	$468	44.7
Labor	271	38.2	496	38.1	702	49.9	427	40.8
Equipment	39	5.4	67	5.2	54	3.8	52	4.9
Office and management	71	10.0	100	7.7	91	6.4	86	8.2
Other direct costs*	14	1.9	19	1.4	6	0.4	14	1.4
Total	$712	100.0	$1300	100.0	$1410	100.0	$1046	100.0

* Insurance on potatoes in storage.

As labor and building constitute 85 per cent of all warehousing costs, the curve of decrease with volume will represent a combination of these two curves. This means that it will be less bent than the curve for labor, and more bent than the curve for buildings.

The problem of whether or not to install a conveyor system is an important one. If No. 26, with 83,000 hundredweight of potatoes,

had installed the conveyor system now in No. 30, with 14,400 hundredweight, the annual equipment cost of warehousing resulting would have been 0.31 cent per hundredweight, instead of the 1.82 cents when installed in No. 30. The highest warehouse equipment cost is for a warehouse with an elaborate conveyor system costing $1500 which handled only 21,600 hundredweight the year of the survey. The data observed are not sufficiently detailed and accurate for the purpose, but it should be possible to determine with what volume of business a conveyor system will save enough labor to warrant its installation.

Another major cause of variations in warehousing cost is amount of storing done and the period for which stored. Unfortunately the data obtained are not sufficiently accurate to warrant publishing any comparative cost figures. The clearest evidence appears in the case of warehouses built especially large in order to provide storage space.

CAR LOADING COSTS

Car loading represents 4.7 per cent of all warehouse costs. It is therefore of about equal importance with receiving. Table XLIX shows that labor is 60.9 per cent of car loading cost, and equipment 19.8 per cent. The process includes, in most cases, either elevating the sacks to the second floor or conveying them in a sack elevator directly to the cars. Of the 71 warehouses, 53 had sack elevators. If no sack elevator is provided, the sacks are trucked into the car from the warehouse. The line houses are as well equipped, on the whole, with car loading equipment as are the co-operative warehouses. The decrease of car loading costs with volume follows a curve bent somewhat more sharply than the labor curve. One sack elevator serves any ordinary sized potato warehouse; hence the equipment cost of car loading decreases very rapidly with volume. The other variations in car loading costs are due to difference in wage rates, utilization of labor, and the like. A minor cause of variations is the cost of car lining and labor of preparing the cars. The line houses line fewer cars than do the others.

TABLE XLIX

ELEMENTS OF CAR LOADING COSTS

	Line		Co-operative		Independent		All	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Labor	$ 75	52.4	$181	64.8	$233	63.5	$140	60.9
Equipment	40	27.6	50	18.0	53	14.5	46	19.8
Office and management	22	15.2	27	9.7	36	9.9	26	11.3
Other direct costs*	7	4.8	21	7.5	44	12.1	18	8.0
Total	$144	100.0	$280	100.0	$365	100.0	$230	100.0

* Car linings.

SELLING COSTS

Selling costs, consisting of the part of office cost which was not charged to buying, and about 35 per cent of the managers' salaries, represent 22.6 per cent of the costs of line houses, 7.5 per cent of those of co-operative houses, and 10.0 per cent of those of independent houses. On a hundredweight basis, the comparison is as follows: line, 7 cents; co-operative, 1.6 cents; independent, 2.1 cents. The difference is largely because the line-house organization does its own selling, whereas only 6 of the co-operatives did most of their own selling. The effect of different methods of selling has already been discussed under office and management.

The selling process includes, for a co-operative or independent warehouse doing its own selling, the following: finding buyers; securing cars; looking after the potatoes en route, at inspection points, and at destination; negotiating with buyers after the cars have reached their destination; collecting from buyers; collecting claims against railroads; all correspondence connected with the foregoing; keeping all records connected with the sale; and if the warehouse is using pooling methods, prorating expenses and receipts among the various growers in the pool. For a warehouse consigning to an exchange or commission firm or broker, selling includes only selecting the agent, securing cars, collecting claims against railroads, and negotiating with agents.

Variations in selling cost are also in large part due to differences in volumes handled by various warehouses. The analysis of variations in office and management cost can be applied almost directly to variations in selling cost, as the separation of office and management cost between buying, selling, and supervision was largely made on the basis of very rough estimates. A few of the office costs, however, were charged directly to selling, in particular, market service, telegraph, and advertising and publicity. Most of several miscellaneous items, such as traveling expense and collections, was also charged to selling. Interest cost should vary, as already explained, with methods of selling as well as with methods of buying.

If a warehouse undertakes to do its own selling, this becomes the most important of its functions. Keeping selling costs down in such a case is always important, but not so important as selling to good advantage. Market and telegraph service may be worth all they cost or they may not. Some warehouses could afford to spend more for such service, some are spending too much already. In the first place, a small volume of business will not warrant an elaborate system of news and telegraphic service. In the second place, unless market information is properly used, it may do more harm than good. It is

much to be doubted if many local managers are in a position to use market information to much advantage. Using the telegraph in making sales, however, may be well worth while.

It is very clear, from the records, that some of the larger warehouses covered in the survey have developed outlets for their potatoes and are handling their own selling to good advantage.

SIDELINES

The cost of handling potatoes may be somewhat affected by the handling of sidelines. For example, enough flour, feed, and other supplies may be handled to keep the warehouse in use throughout the year; and a manager may be employed on a yearly basis. If the sideline business is important enough, it can properly be made to bear some part of the warehouse costs. It will, in most cases, be proper to charge only that part of management costs to sidelines which is additional because of taking in the sideline business. Working capital may also be put to fuller use by taking on sidelines.

As only 3 of the 71 warehouses handled sidelines to any appreciable extent, it was not possible in this survey to make any analysis of their effect. The procedure followed was to separate the costs directly chargeable to sidelines, and divide salaries and interest between potatoes and sidelines as above indicated.

CENTRAL MARKET COSTS

The principal central market and transportation costs that come out of the net proceeds of a car of potatoes are: freight, brokerage and commissions, inspection fees, car messengering, switching, demurrage, trackage, and a miscellaneous lot of other transportation costs. As already explained, these costs have been omitted from the analysis for two reasons: (1) They are not costs of the local warehouse as such, and (2) the data obtained did not always separate central market costs from deductions due to damage in transit, quality defects, and the like.

Following this procedure does not, of course, give costs on a comparable basis of the locals following different selling practices, as office and management costs are higher for those selling direct to retailers than for those selling on track, and higher for those selling on track than for those consigning to brokers and commission men. It has already been roughly estimated that office and management costs averaged $7 per car higher for those selling direct than for those consigning (see page 52). With this figure may be compared part of the 10 cents per hundredweight, or $36 per car charged by the Minnesota Potato Exchange for its services—only part of it, because

the exchange rendered some services not ordinarily performed by a local doing its own selling. It may also be compared with the $13 per car (average for about a thousand cars actually sold) charged by brokers and commission merchants when these agencies did the selling. There is little doubt that local potato warehouses that have developed outlets of their own for their potatoes are able to handle the selling at a lower cost than they can hire it done for them. There is, however, the initial cost of developing such outlets, and the risks involved in dealing with new customers for the first time.

To put the costs of co-operative and independent warehouses on a comparable basis with those of line houses, these charges of $7, $36, or $13 per car must be added to the local cost, for the line houses do all their own selling. Certain other expenses should be added also, such as demurrage, switching, inspection fees, and the like, for these are included in the central office expenses of line houses as given in the tables. These amount to about $2 per car. The central office expenses of line houses as given also include payment to the railway company for preparation of cars ($5 per car) when it was not done by the local warehouses, and payment to the railway company for messengering, car-heating, and all services included when potatoes are shipped under "Option No. 2"—the line houses ship almost altogether on this basis. The charge under this option was $12.30 per car.

LEAST-COST COMBINATION

Obviously no one element of cost can be considered by itself alone. The more spent for equipment, work done (quality being the same) the less the labor required. A conveniently arranged warehouse also reduces the labor required. Given data as to the amount of labor saved by various items of equipment, and as to the cost of equipment and wages of labor, it should be possible to estimate with fair accuracy what equipment it will be economical to install—in other words, determine what combination of labor and equipment will render a given amount and quality of service at the least cost per unit. The data obtained in the survey, however, were not accurate enough to warrant such an analysis.

COST AND AMOUNT OF SERVICE

Throughout the bulletin, it has been obvious that costs of different warehouses have not been comparable because of differences in the amount of service rendered. For example, some warehouses have sold all or most of their potatoes and others have sold few or none. Some have stored more potatoes than others; some have stored for longer periods than others. Some have done the weighing for growers

and some have not. Some have provided dumps and some have not. In some cases it has been possible to estimate the difference in costs resulting; in others, not. As a factor in variations in total cost per hundredweight, however, it is one of the most important.

COST AND QUALITY OF SERVICE

In scores of ways, one warehouse may render better service than another, by sorting and grading better, by keeping the potatoes in better condition in storage, by loading cars better, and last and most important of all, by selling for a better price. Obviously no way was possible in this analysis of measuring these differences in quality of service.

ALL COSTS COMBINED

Having analyzed the various elementary costs separately and combined by processes, they can now be combined into total costs per warehouse and per hundredweight. Figure 15 shows the five elements of cost reduced to a hundredweight basis and combined. The office and management cost here included is for co-operatives and independents only—line-house office and management costs include a large element of central office costs arising from selling operations not usually performed by local warehouses. The range with volume of business is from 28.24 cents for houses handling 5000 hundredweight, to 18.57 cents for houses handling 80,000 hundredweight, or a total range of 9.67 cents, or 45.4 per cent of the average of 21.29 cents. The largest absolute range with volume was for building and site cost, at 3.40 cents, with labor next, at 2.80 cents. The percentage range (per cent of the average) was also highest for building and site cost, at 113 per cent, but second for equipment, at 92 per cent. Labor cost is fourth in percentage range, at 48 per cent, and office and management third, at 61 per cent. Figure 15 shows only the absolute range.

It is apparent from the diagram that most of the economies of larger volume of business, so far as warehouse costs are concerned, appear under 30,000 hundredweight, and more than half of them under 20,000 hundredweight. Building and site and equipment are responsible for 3.5 cents of the saving in costs under 20,000 hundredweight, and labor and office and management for 2.7 cents.

Curve A in Figure 16 reproduces the combined curve of Figure 15, and locates the costs for the 38 co-operative and independent warehouses. The absolute range in costs from all causes for co-operative houses is from 15.3 cents for No. 22 to 37.2 cents for No. 7. The absolute range from all causes for independent houses is from 13.3 cents for No. 33 to 31.4 cents for No. 30. Thus the absolute range for both groups is from 13.3 cents to 37.2 cents, or 23.9 cents.

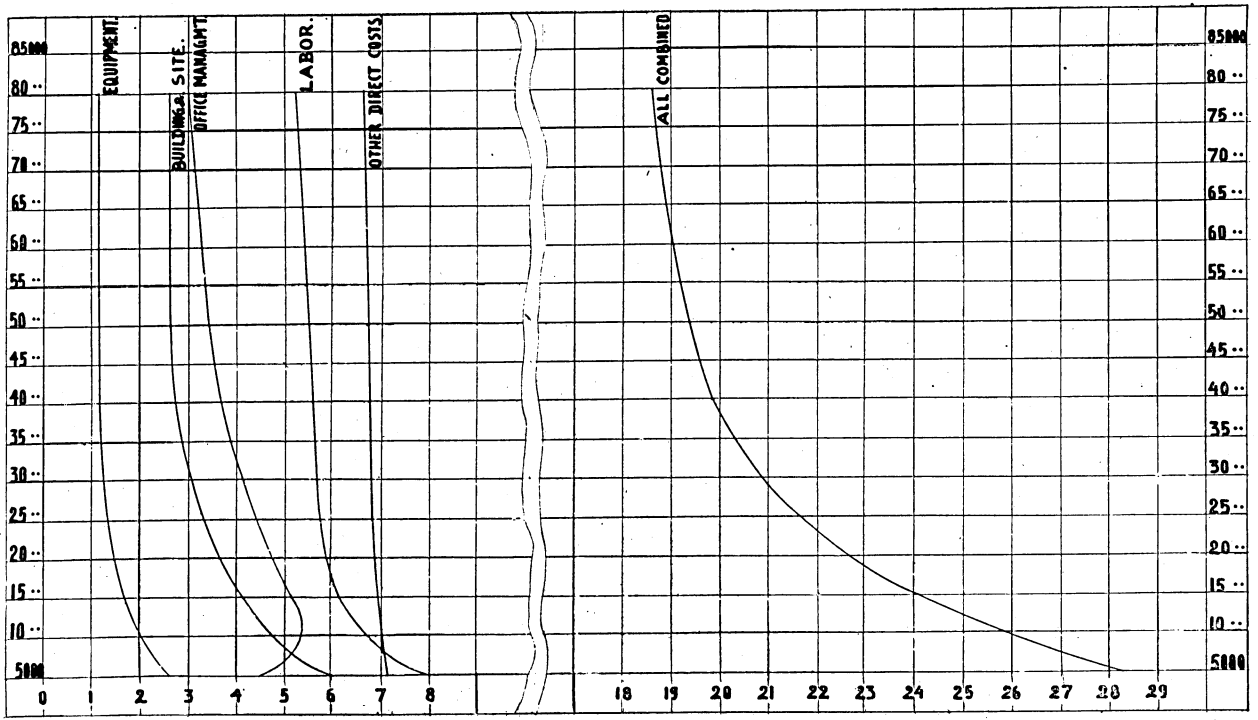

Fig. 15. Elements of Cost Combined According to Volume of Business
The office and management costs given are for co-operative and independent warehouses only.

Volume of business accounts for only 9.67 cents of this. Thus 17.2 cents of it must be due to the other causes that have been pointed out. This is very evident from the diagram. In any volume group—for example, from 15,000 to 25,000 hundredweight—there is a wide range in cost.

It is thus apparent that warehouse costs are very irregular. Some of these irregularities can not be obviated. Any progressing industry is sure to exhibit considerable variation in costs. If none could reduce their costs below those of their competitors, little progress would be made. But it is equally clear that the high costs of many of these warehouses are entirely unnecessary, and could be at least partly eliminated in any season. Others could have been prevented if the warehouse had been properly planned at first. As time goes on, the potato warehouse business will surely be more standardized—warehouses will be more nearly of the same size and construction, with more nearly the same equipment. Also salaries of managers will be more nearly uniform. These standardizations will nearly all be in the direction of lower costs.

Any warehouse manager will do well to calculate his costs for last year's business upon a hundredweight basis and compare his results with the average indicated by Curve A in Figure 16. If he finds that his average is high, he should separate out the various elements making up his total costs and compare each of these with the proper curve in Figure 15. Having discovered which of his costs are high, he can then read carefully the analysis of factors causing variations in that cost, to see if he can discover the causes responsible in his case. Even tho his total costs may be low, he may find that some of his separate costs are high and can be reduced.

As already pointed out, however, he must not conclude in all cases that because certain costs are high he must go about reducing them. It may be that the extra cost is due to extra service or better quality of service rendered, and may be more than warranted.

Curve B in Figure 16 represents the average combined costs per hundredweight for the 33 line houses. It will be remembered that office and management costs of line houses averaged 13.1 cents per hundredweight, as compared with 3.9 cents for other warehouses, and that 72 per cent of these office and management costs were incurred by the central office; and further, that the central office costs were prorated to the locals at a flat rate per hundredweight. Curve B has been adjusted somewhat for the probable error arising from this method. Line house costs are somewhat more regular than those of the other two classes of warehouses, but the extreme range is from 24.9 cents for No. 47 to 46.9 cents for No. 48.

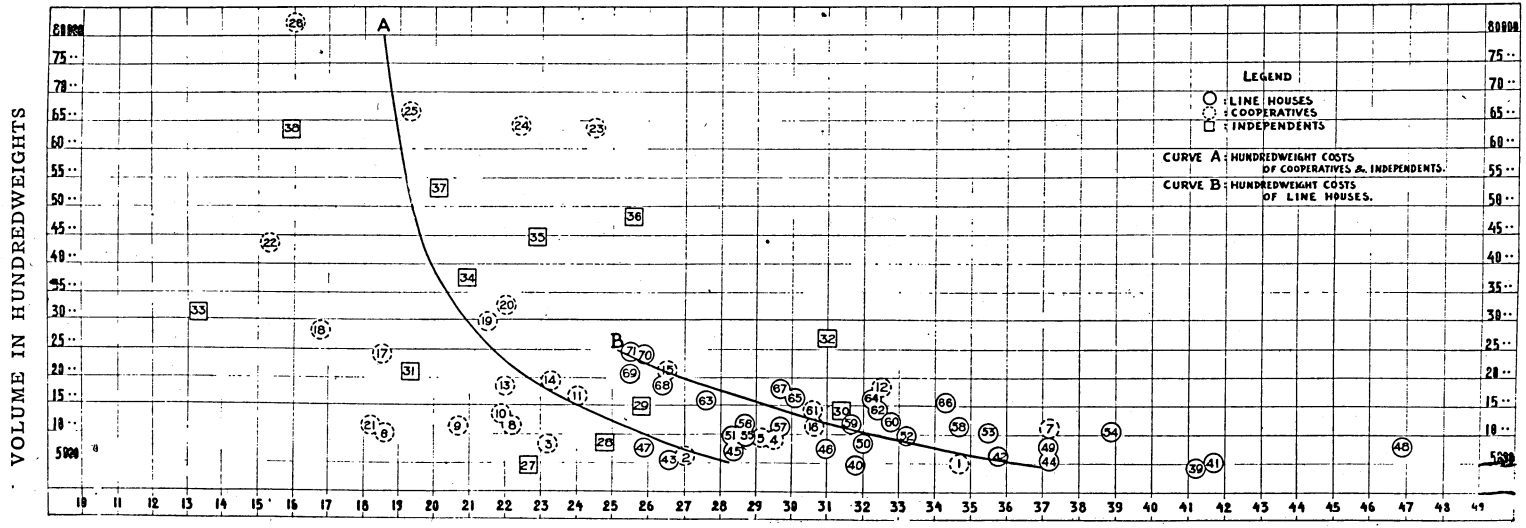

Fig. 16. Relation of Volume of Business to Warehouse Cost per Hundredweight for Co-operative and Independent, and Line Warehouses

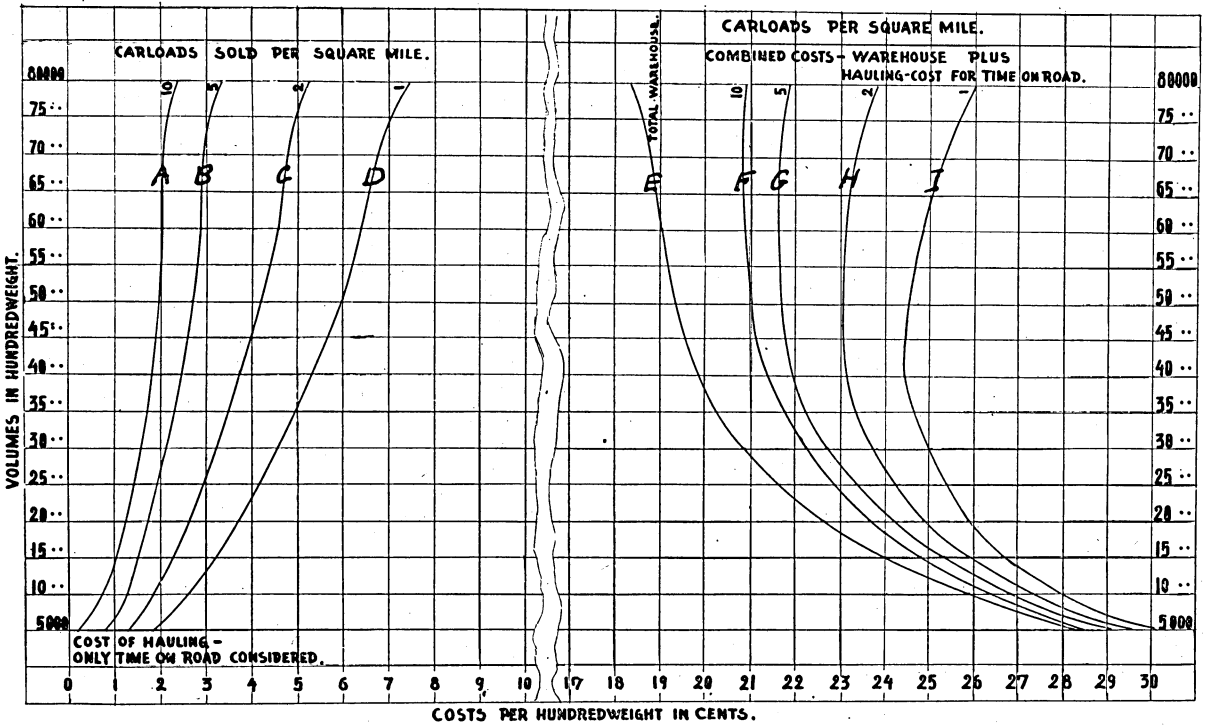

Fig. 17. Hauling Costs

Hauling costs must be considered in determining the most economical size of business. Larger businesses are more economical where production is dense.

SIZE OF WAREHOUSE

The question of the most economical size of warehouse and volume of business must be considered from a community standpoint, rather than from a strictly warehouse standpoint. The larger the volume of business handled at one market place, the farther the potatoes must be hauled and the greater the cost of hauling. The more warehouses at one shipping point, the less business to be handled by each, but perhaps the more convenience in unloading and storing. Figure 17 illustrates the method of analyzing this problem for length of haul and number of warehouses at a shipping point. The length of haul required to obtain a given volume depends upon the density of production. Most potato growing sections in the state range between one and ten carloads per square mile. Clay County averaged over six carloads in 1922. It is impossible to compute accurately any hauling costs for farm products, but one can come as near to a correct figure for hauling potatoes as for any other crop, because some potatoes are actually hauled by special labor hired for the purpose, and most potatoes are hauled at a busy season. Studies made of wage rates for man labor and horse labor employed on Minnesota farms under conditions similar to those prevailing during potato-hauling periods of the year, indicate that 60 cents per hour is somewhere near an average for the farms in most communities. The rates on different farms will probably vary from 40 to 90 cents an hour, depending upon the other farm enterprises combined with potatoes, and the proportions between them, and the supply of labor, as well as upon rates paid for hired labor; but it is probably fairly safe to use an average in this case, as crop combinations will not be greatly different at different distances from the market. Time spent loading and unloading can be ignored as it is a constant amount regardless of the length of haul, except that those living farther away arrive later and are likely to have to wait longer to unload. Hence only time on the road need be considered in the present problem. A rate of travel of three miles per hour has been assumed, and 50 bushels of potatoes to a load. The four curves in the left of the diagram represent hauling costs under these assumptions for time on road only, and for an average haul. The method of computation is as follows:

Commercial production of 5 carloads per square mile:

40,000 cwt.=111.1 carloads (360 cwt.=1 carload).

111.1 carloads will require 22.2 square miles of area.

$\sqrt{\frac{22.2}{3.1416}}$=2.66 mi.=radius of circle with area of 22.2 sq. miles.

2/3×2.66 mi.=1.77 mi.=average length of haul one way for an area 2.66 miles in radius.

2×1.77 mi.=3.55 mi.=length of trip both ways.

$\frac{3.55}{3}$=1.18 hours=time required, at 3 miles per hour.

1.18×$0.60=$0.708=average cost of trip, time on road only, at $0.60 per hour for man and team.

$\frac{\$0.708}{30}$=$0.0235=cost per cwt. at 30 cwt. per load.

Table L gives the results of such computations for four different densities. It is presumed, however, that persons using this bulletin will make their own assumptions as to density, rate of travel, cost per hour, size of load, and other items.

The foregoing analysis also assumes that one warehouse handles all the business, which is seldom the case. If a given area sells ten carloads per square mile, but has two warehouses which divide the business equally, the results are the same as tho the density were 5 carloads per square mile and one warehouse were handling it. Therefore Curve B would fit rather than Curve A. If there were 5 warehouses in place of one, a more likely assumption, Curve C would fit. It is probable that Curves C and D come nearest to fitting most actual conditions.

Curve E merely reproduces the warehouse cost curve of Figure 15. Curves F, G, H, and I combine Curve E with Curves A, B, C, and D, respectively. It will be noted that if one sold ten carloads per square mile, and delivered at one warehouse, the most economical volume of business would be appreciably above 80,000 hundredweight; and at 5 carloads per square mile it would be somewhere just above 80,000 hundredweight; but according to Curve H, which will more nearly fit most situations in the state, the most economical volume of business would be 50,000 hundredweight. Curve I represents a condition that exists at many shipping points because there are too many warehouses —lowest combined costs around 40,000 hundredweight.

TABLE L

RELATION OF HAULING COSTS TO VOLUME OF BUSINESS FOR DIFFERENT DENSITIES OF COMMERCIAL POTATO PRODUCTION‡

Volume in hundredweight (000's omitted)	10 Carloads§			5 Carloads§			2 Carloads§			1 Carload§		
	Area required	Average haul*	Cost per cwt.†	Area required	Average haul	Cost per cwt.	Area required	Average haul	Cost per cwt.	Area required	Average haul	Cost per cwt.
	Sq. mi.	Mi.	Cents	Sq. mi.	Mi.	Cents	Sq. mi.	Mi.	Cents	Sq. mi.	Mi.	Cents
5	1.4	0.28	0.18	2.8	1.27	0.83	6.9	1.97	1.31	14.0	2.81	1.87
10	2.8	1.27	0.83	5.5	1.96	1.31	13.8	2.81	1.78	28.0	3.96	2.65
15	4.2	1.55	1.41	8.3	2.17	1.44	20.8	3.43	2.28	42.0	4.85	3.24
20	5.5	1.96	1.31	11.1	2.50	1.66	27.8	3.96	2.65	55.0	5.57	3.71
25	6.9	1.98	1.33	13.9	2.80	1.68	34.8	4.43	2.95	69.0	6.24	4.17
30	8.3	2.17	1.44	16.7	3.07	2.04	41.8	4.85	3.24	83.0	6.83	4.56
40	11.1	2.50	1.66	22.2	3.54	2.35	55.5	5.57	3.71	111.0	7.92	5.27
50	13.9	2.80	1.86	27.8	3.96	2.64	69.0	6.24	4.17	139.0	8.95	5.98
60	16.7	3.07	2.04	33.3	4.33	2.88	83.0	6.83	4.56	167.0	9.69	6.38
80	22.2	3.54	2.35	44.4	4.99	3.33	111.0	7.92	5.27	222.0	11.18	7.45

* Both ways.

† Assuming 60 cents per hour for man and team and 30 hundredweight per load, and average rate 3 miles per hour.

‡ Hauling costs are for time on the road only.

§ Per square mile.

If the number of warehouses could be kept to one for 80,000 hundredweight, in an area selling 5 carloads per square mile, the lowest combined cost is 19.8 cents per hundredweight; but if this business is divided among 5 warehouses, the combined cost will be 26 cents per hundredweight. If the commercial production is 2 carloads per square mile, and one warehouse handles it most economically, the combined cost is 21.3 cents per square mile; but if two handle the same volume the combined cost is 23.7 cents per hundredweight.

If, however, a warehouse is to handle 80,000 to 100,000 hundredweight it should be arranged to provide convenient unloading facilities. Moreover, the ratio of potatoes stored to potatoes handled will be low in such a warehouse unless it is built extra large to provide storage, in which case extra building cost will be involved. It is undoubtedly true that the desire to provide storage has been a factor in multiplying the number of warehouses at many shipping points. Line-house organizations, especially, have been actuated by such motives. They find it more economical to store at country stations than in the central market. An analysis to fit a business combining handling and storage on this basis will require data not obtained in the present survey.